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THE PHILIPPINE ANOPHELES OF THE ROSSI-LUDLOWI GROUP [1]

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FOUR PLATES AND SIX TEXT FIGURES

INTRODUCTION

Five species or subspecies belonging to this group (the *Pseudomyzomyia* group of the subgenus *Myzomyia* as defined by Christophers in 1924) are now known to occur in the Philippines. These consist of a local variety each of the species *Anopheles vagus* and *Anopheles subpictus* (*rossi*), two species that have previously been included under the name *ludlowi*, and *Anopheles parangensis*. The latter is known at present only from Min-

[1] The studies on which this paper is based were conducted with the support and under the auspices of the International Health Division of the Rockefeller Foundation, in coöperation with the Bureau of Science, the Philippine Health Service, and the United States Bureau of Entomology.

The author wishes to acknowledge his indebtedness especially to Dr. Victor G. Heiser, who arranged the present investigation of Philippine mosquitoes; to Mr. J. J. Mieldazis, whose familiarity with the territory and the breeding habits of the local *Anopheles* was of much assistance in the early part of the work; and to Mr. F. E. Baisas, who, under the writer's direct supervision, has reared and examined a large part of the mosquito material and who has made a majority of the camera-lucida drawings used as illustrations.

Some of the preliminary work on this and other groups was carried out during the first five months of 1929 and the study was resumed in November, 1930.

danao and the Celebes area but the others are generally prevalent in the Philippines and, with the possible exception of the fresh-water form of *A. ludlowi*, their near relatives are widely distributed in the Orient.

Although a great deal has been published on this group, the correct nomenclature of the Philippine species and their relationship to the forms occurring in other regions has not been satisfactorily settled. A special study of the local forms has therefore been made and comparative descriptions, with consideration of the taxonomic problems, are given in the present paper.[2]

The species described or discussed are shown in the following list:

Anopheles ludlowi Theobald (fresh-water *ludlowi*).
Anopheles litoralis sp. nov. (salt-water *ludlowi*).
Anopheles sundaicus Rodenwaldt (East Indian or Sunda Islands *ludlowi*).
Anopheles flavescens Swellengrebel.
Anopheles hatorii Koidzumi.
Anopheles parangensis Ludlow.
Anopheles subpictus var. *indefinitus* Ludlow.
Anopheles subpictus var. *malayensis* Hacker.

[2] Since this investigation was begun, a study of the group has been made by C. M. Urbino and a summary of his work has appeared in a bulletin of the Philippine Health Service. After the completion of the present article I find that his full manuscript has appeared in a local medical journal, Rev. Fil. Med. y Farm. 22 (1931) No. 5. It is unfortunate that the two studies were not better coördinated as a number of discrepancies have arisen, the most important of which is in the description of the leaflets of the mesosome of the male genitalia. The differences that I have given here and that have now been amply confirmed, were originally demonstrated to Mr. Urbino (for his personal information) following my preliminary work in 1929. From his published conclusions it is evident that some of his identifications, particularly of fresh-water *subpictus*, were at fault since the leaflets of the Philippine *subpictus* and *vagus* are not similar as stated by him. Other less important discrepancies have been noted as follows: (1) The average length given for the palmate hairs is greater than in my series, and it appears that the factor used in converting the ocular measurements to millimeters may have been incorrect. (2) The records of the occurrence of fringe spots between veins 5.2 and 6 are at variance, the only agreement being in fresh-water *ludlowi*. This spot also occurs in a fairly large proportion of my specimens of salt-water *ludlowi* (= *litoralis*) and I have not found it of value in distinguishing between the two species. (3) Several useful distinguishing characters in wing and leg markings are not included in the article.

Anopheles formosaensis II Tsuzuki.
Anopheles subpictus Grassi (type form).
Anopheles subpictus var. *indefinitus* from brackish water.
Anopheles vagus var. *limosus* var. nov.

At the beginning of the study in 1929, it was planned to collect and compare a large enough series of each of the commoner varieties to determine, if possible, the extent of normal variation, both in larval and adult characters. This was felt to be necessary on account of the close similarity between some of the forms and the confusion that has existed as to their relationship.

Larval breeding habits were also taken into account and, in order to become familiar with the distribution and preferred breeding places of the different species, nearly all of the collections were made in person, frequently accompanied by Mr. Mieldazis during the first four months of the work. When making the collections, the specimens from each breeding place were kept separated until identifications could be made so as to have exact records of their source and to determine the extent of association or lack of association of species.

Upon arrival at the laboratory, the fourth-stage larvæ were examined alive, counts of various hairs were recorded on a tabular form, and the specimens were then given an individual sub-number and isolated in small Petri dishes for rearing. Nearly all of the adults included in the study were from such identified and described larvæ. The cast larval skin from each individual was mounted and preserved under its proper number for reference purposes. Some of the characters are best observed in entire larvæ, but the cast skins have proven of value especially in checking the identification, in cases where some question arises later, and in looking up characters not originally noted.

The technic employed in the examination of the male genitalia differs somewhat from the usual methods. The leaflets of the mesosome (phallosome) have proven to be especially useful in the differentiation of certain members of this group, and in order to examine them under high magnification it is almost necessary to dissect off the mesosome, after the usual treatment of the genitalia with caustic soda, and to mount it under a separate cover glass. By this means the leaflets may be spread out and pressed down into one plane. If desired, the mesosome may also be split into two parts and the two halves separated in mounting so that the leaflets of one side do not overlie those

of the other. Care must be taken in the dissections that some of the leaflets are not broken off. Most of the specimens have been mounted in Gater's modification of Berlese's solution, which has a good index of refraction and with which the mesosome may be transferred directly from water.

The results of the present studies, combined with those of other workers, indicate with little question that the Philippine forms of this group are specifically distinct one from another. The recognition of Philippine varieties of the type forms of *vagus* and *subpictus* also appears warranted on the evidence available.

With reference to the use of a varietal as well as a specific name, the objection is sometimes made that the splitting of species does more to confuse than clarify the situation for the field worker. However, where the differences justify it, the practice is recognized as necessary for proper systematic treatment and, from the viewpoint of the field work, the use of varietal names is undoubtedly desirable in many cases if for no other reason than to indicate the affinities of the species and to call attention to the possibility of differences in habits. The lack of information on such differences, or the failure to recognize them, has resulted in considerable confusion as regards the connection of certain species with the transmission of malaria.

The group here dealt with is thought to be sufficiently well known so that the general characteristics may be omitted. The descriptive matter is therefore largely limited to comparative data. Tables have been added to show the occurrence of certain variable characters in the adults and larvæ and include some information not noted in the text.

Although some collecting of *Anopheles* has been done on islands other than Luzon, the comparative matter included here, with the exception of that pertaining to *Anopheles parangensis*, is restricted to Luzon material.

ANOPHELES LUDLOWI Theobald, 1903.

The two speckle-legged species that occur commonly on Luzon Island have been locally referred to in recent years under the names of salt-water and fresh-water *ludlowi*. Outside of the Philippines, it has not, I believe, been generally known that more than one species occur in the Islands and comparisons have been made sometimes with one and sometimes with the other of the two forms as representing typical *ludlowi*.

The original description of Theobald does not definitely show to which one of the two species the name should be applied and, according to Yamada (1925), the type specimen in the British Museum is now in poor condition. Nevertheless, the very definite statement by Miss Ludlow (1914) that the specimens on which the description was based were from an inland locality (Abra Province, Luzon), well removed from any salt-water source, would appear to settle the matter sufficiently clearly since, in numerous collections made by the members of the International Health Division and the Philippine Health Service, one of the forms has been found only in fresh-water breeding places associated with streams and the other only in salt-water ponds or pools near the coast.

Christophers (1924) called attention to the fact that the true *ludlowi* was not the species usually referred to as such but refrained from changing the name, in order to avoid confusion, and suggested that the fresh-water species be considered merely as *parangensis*. In the meantime, however, *parangensis* has been shown to be a distinct species and the East Indian form to differ from the type form. Since the latter, probably the most important member of the group, has now been renamed there is, of course, much less reason for arbitrarily retaining the name *ludlowi* to designate the salt-water species. Furthermore, it is probable that the strict application of the name would in any event be proposed sooner or later. After considerable thought, it has been decided to restrict the name to the fresh-water form in the present article and to propose a new name for the Philippine salt-water species.

The principal characters of *A. ludlowi*, based on a series of specimens from various fresh-water breeding places, are as follows:

Female.—Costal sector spot[3] of wings (Plate 1, fig. 1) invariably present in the material at hand; two white interruptions between this and the base of the wing; basal accessory dark spot without white scales on the anterior margin but a few white scales usually present over the bend near the extreme base of the wing; accessory sector spot on the subcostal vein present in about 40 per cent of the specimens, 44 per cent with three dark spots under the midcostal area, and 67 per cent with a dark patch of scales (sometimes only two or three) at the fork of vein 2; subapical dark costal spot forming from 29 to

[3] The terms used to designate the wing spots are shown in text fig. 1.

48 per cent of the area included in the costal measurement (see fig. 1), with an average of 37 per cent; vein 5.1 with an average of 35 per cent black to the total length of the branch; stem of vein 2 (measured from the supernumerary cross vein) about nine-tenths the length of the cell.

The fossa of the mesonotum (that is, the depressed lateral area in front of the suture) either bare of scales or with a few narrow ones similar to those on the dorsal surface—at most, one or two broad flat scales.

Legs, except for the white speckling, usually dark scaled ventrally as well as dorsally; white apical bands of mid tarsi usually slightly narrower than those on the hind feet; basal bands absent on the mid and hind feet or, if present, very indistinct.

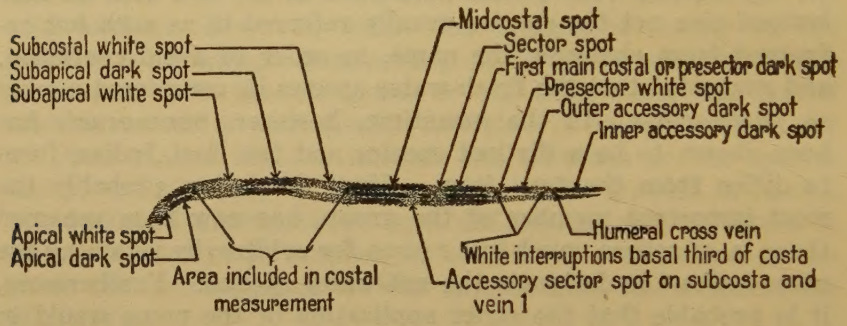

FIG. 1. Terms employed to designate the costal wing spots. Most of the names have been adapted from those used by S. R. Christophers and others.

Subapical black palpal band averages six-tenths the length of the apical white area; the latter frequently divided into two by an additional narrow band of black scales at the base of the apical segment.

Male genitalia.—Mesosome with three or four main leaflets (Plate 3, fig. 3, and Plate 4, fig. 3) on each side, the first one long, stout, widened near the base and S-shaped, with serrations on the outer edge of the lower curve; the next three or four leaflets also stout but progressively shorter, some of them also serrated. There are usually several short spikes at the base, or occasionally a longer slender leaflet. The long S-shaped leaflet averaged 53 μ in length in nine specimens, and the measurements for the next two in a typical group were 49 and 30 μ.

Larva.—Outer clypeal hairs more than half the length of inner; about three-fourths (77 per cent) of the outer occipital

hairs with four or more branches; anterior submedian thoracic hairs usually with more than nine branches each; thoracic palmate with an average of 3.6 hairlike branches; palmate of first abdominal segment with an average of 3.2 branches, not developed as leaflets (fig. 4, *c*); lateral hairs of abdominal segments IV to VI may or may not be irregularly branched but the first branches arise some distance from the base leaving a distinct "stalk" (fig. 5, *f*); the lateral hairs frequently 4-branched on

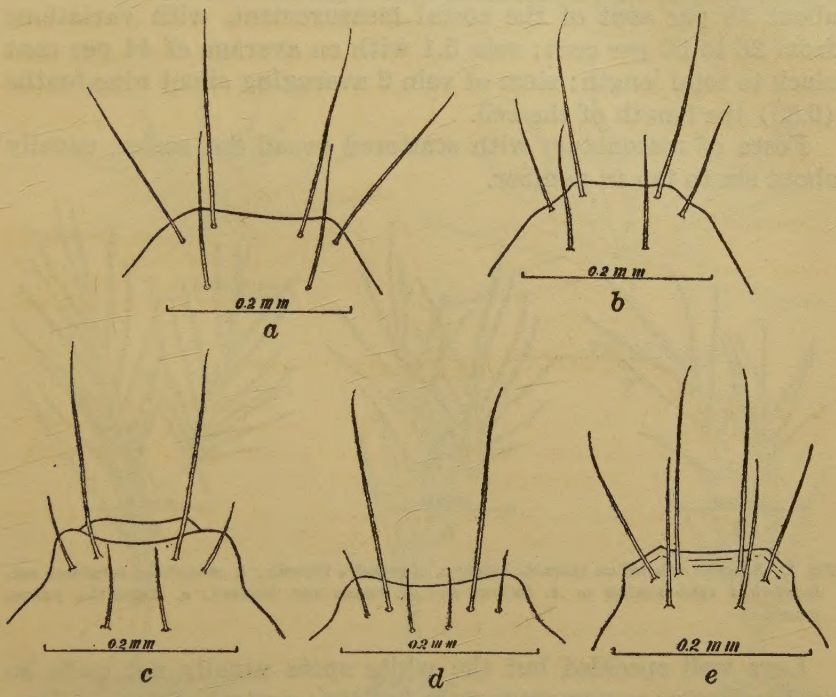

FIG. 2. Larval clypeal hairs; *a, Anopheles litoralis; b, Anopheles subpictus* var. *indefinitus* (also similar to *A. ludlowi*); *c, Anopheles vagus* var. *limosus; d, Anopheles vagus*, type form from Java; *e, Anopheles parangensis.*

segment IV and 3- or 4-branched on segments V and VI; pecten with short and long teeth of nearly equal length (fig. 6, *c*).

ANOPHELES LITORALIS sp. nov. (Salt-water ludlowi.)

Female.—Costal sector spot of wing incomplete or absent in about 30 per cent of the specimens (see Table 3 and Plate 1, fig. 2); basal third of costa with two or three white interruptions; basal accessory dark spot almost invariably with some white scaling on the anterior margin, sometimes completely interrupting the black (counted as one of the basal white spots

in the latter case); accessory sector white spot of subcostal vein present in 70 per cent of the specimens examined; vein 1 under the midcostal area with two dark spots, the basal one sometimes with only one or two dark scales separating the sector from the accessory sector spots; stem of vein 2 without a patch of dark scales at the fork, the only exceptions among eighty-eight specimens being two with one or two dark scales at this point and six in which the usual dark spot on the center of the stem extended nearly to the fork; subapical costal dark spot forming about 38 per cent of the costal measurement, with variations from 26 to 50 per cent; vein 5.1 with an average of 44 per cent black to total length; stem of vein 2 averaging about nine-tenths (0.88) the length of the cell.

Fossa of mesonotum with scattered broad flat scales, usually about six to ten in number.

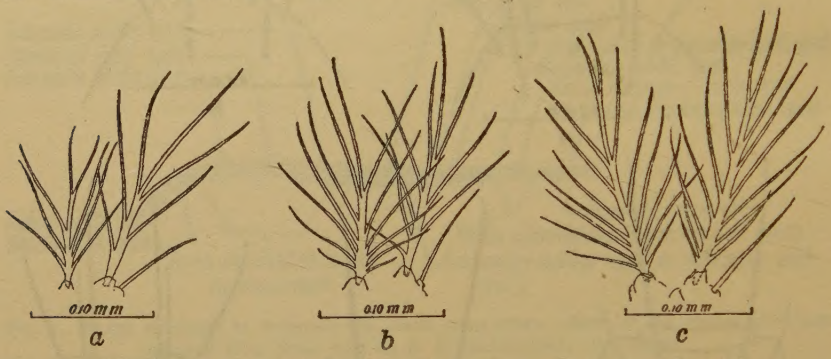

FIG. 8. Anterior submedian thoracic hairs; *a*, *Anopheles litoralis*; *b*, *Anopheles subpictus* var. *indefinitus* (also similar to *A. ludlowi* and *A. vagus* var. *limosus*; *c*, *Anopheles parangensis*.

Legs well speckled but the white spots usually not quite so contrasting or so numerous as in *ludlowi;* ventral surface of legs, especially the mid and hind femora and tibiæ and the fore tarsi, partly or almost completely yellowish scaled; segments 3 and 4 of the mid tarsi, frequently segment 2, with narrow though distinct basal white bands,[4] in addition to the apical bands of the preceding segment; segments 3 and 4 of hind legs often with very narrow basal bands also.

Palpal bands variable, the subapical black averaging slightly more than half (0.58) the length of the apical white; apical segment without an additional black band as observed in specimens of *ludlowi.*

[4] Noted by Yamada (1925) as differences between *A. hatorii* and what he took to be true *A. ludlowi* but were evidently the salt-water form.

Male genitalia.—Mesosome with from 8 to 14 leaflets on each side (Plate 3, fig. 1, and Plate 4, fig. 1), subequal in length except for short spikes at the base. In the ordinary mounts the leaflets are usually bunched so that the number and shape of the leaflets cannot be made out easily. When the mesosome is separated and mounted under a separate cover glass the longest leaflets and some of the others are found to be typically thin and flattened, with one side broadly rounded toward the tip and the other more or less straight and serrated. The longest leaflet,

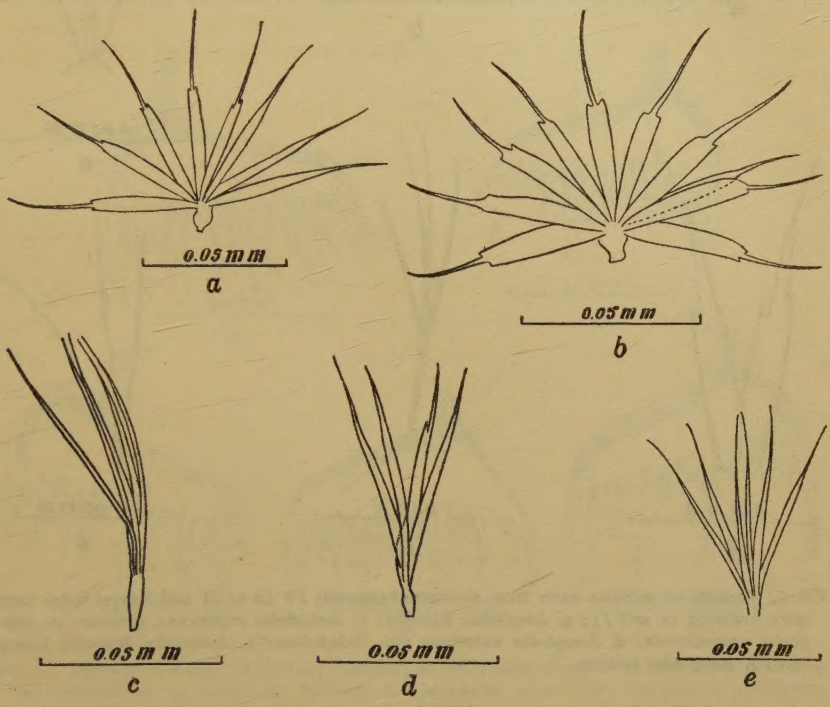

FIG. 4. Palmate hairs of first abdominal segment; *a*, *Anopheles subpictus* var. *indefinitus*; *b*, *Anopheles parangensis*; *c*, *Anopheles ludlowi*; *d*, *Anopheles vagus* var. *limosus*; *e*, *Anopheles litoralis*.

with an average length of about 42 μ, is much shorter than and differs in shape from that of either *ludlowi* or *vagus*. The leaflets are, however, similar to those of the Philippine *subpictus* except possibly for a slight difference in number and length.

Larva.—Clypeal hairs similar to those of *ludlowi* and *subpictus* except that the outer appear to be slightly longer (fig. 2, *a*); all clypeal hairs usually simple but occasionally forked or double;

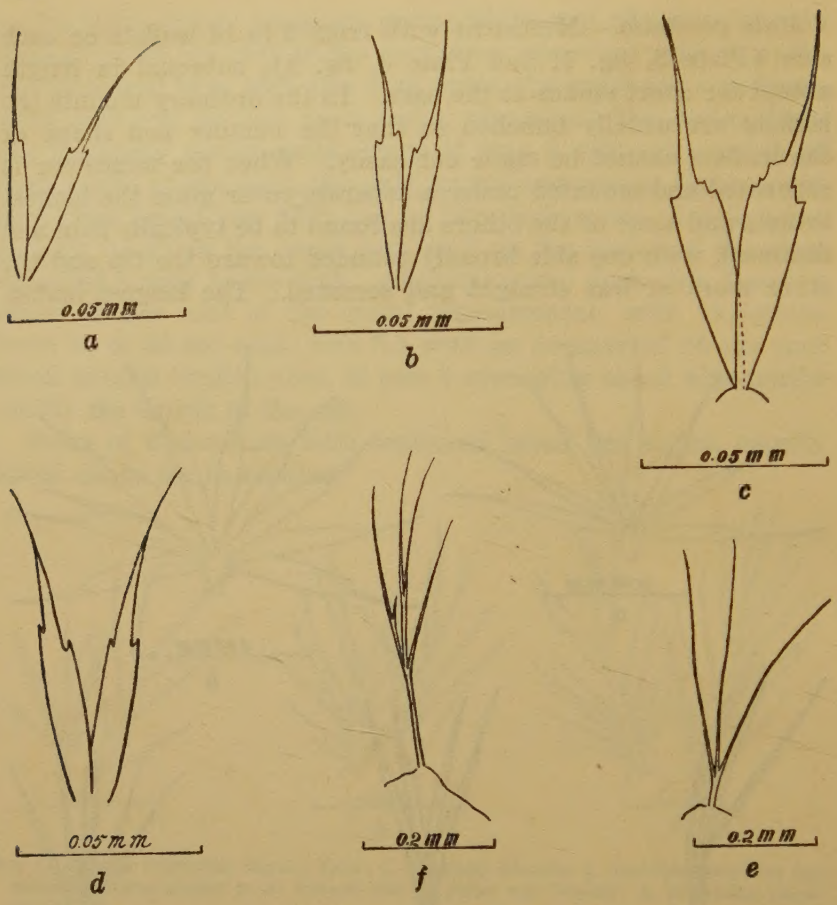

FIG. 5. Leaflets of palmate hairs from abdominal segment IV (*a* to *d*) and lateral hairs from same segment (*e* and *f*); *a*, *Anopheles litoralis*; *b*, *Anopheles vagus* var. *limosus*; *c*, *Anopheles parangensis*; *d*, *Anopheles subpictus* var. *indefinitus*; *e*, *Anopheles litoralis*, lateral hair; *f*, *Anopheles ludlowi*.

outer occipital hairs very seldom with more than three branches; anterior thoracic hairs (fig. 3, *a*) usually less than 9-branched;[5] thoracic palmate with three or two (average 2.3) hairlike branches; palmate I also undeveloped, with an average of 5.3 hairlike branches (fig. 4, *e*); leaflets of other palmates smaller

[5] Table 6 shows 91 per cent of the hairs with less than nine branches. However, in another series of larvæ recently examined (1931) only 62 per cent had less than nine and the average number was eight instead of less than seven in the previous series. There were four out of forty-seven larvæ in the second series in which all four hairs had more than eight branches.

than in subpictus (fig. 5, *a*) ; lateral hair of segments IV to VI usually 3-branched, the branches arising near the base, without an elongated stem as in *ludlowi* (fig. 5, *e*) ; antepalmate of segment VI 2- or 3-branched in about half (47 per cent) of the specimens; pecten with long and short teeth of nearly the same length (fig. 6, *a*).

Type female.—Reared from larva collected in a salt-water fishpond near Parañaque, Rizal, Luzon, December 24, 1930.

The form of branching of the lateral hairs is usually reliable for separating the larvæ of *ludlowi* and *litoralis,* while the num-

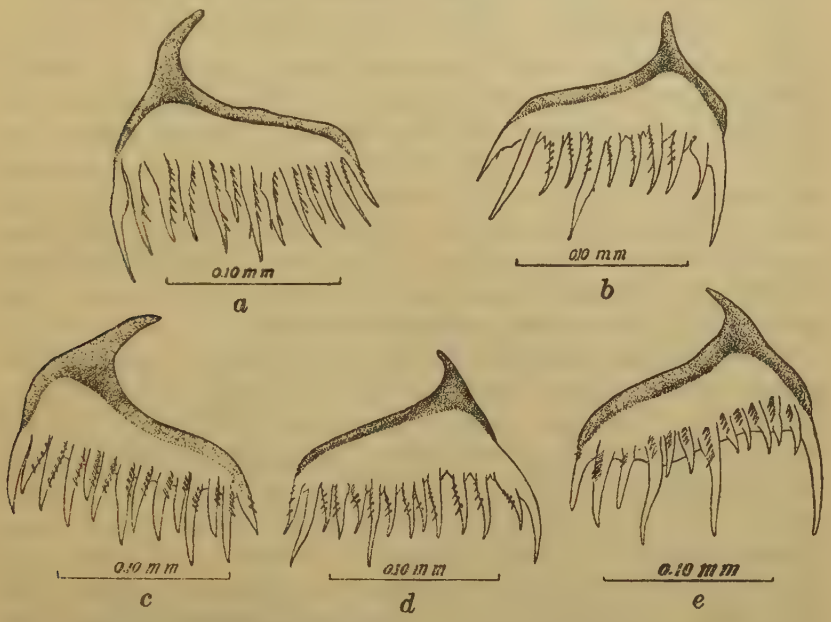

FIG. 6. Pectens of eighth abdominal segment; *a, Anopheles litoralis; b, Anopheles subpictus* var. *indefinitus; c, Anopheles ludlowi; d, Anopheles vagus* var. *limosus; e, Anopheles parangensis.*

ber of branches in the anterior thoracic hairs, the outer occipital hairs, the undeveloped thoracic palmate and palmate I, and the antepalmate hairs of segment VI may be useful for confirmation, especially in a series. The only species with which *litoralis* larvæ have been taken is the brackish-water breeding *subpictus.* The most useful characters for separating these two are the shape of the pectens and of the palmate hairs on segment I.

The first description of this form, under the name of *ludlowi,* appears to be that of Banks (1907) who described the male and

larva and gave an account of the life history. Although the characters given are not sufficient to recognize the species with certainty he states that the material was from salt-water sources.

Yamada appears to be the first to indicate specific differences in the markings of the two forms. (See remarks under *A. hatorii.*)

The breeding places of *litoralis* are discussed below in connection with those of *sundaicus.*

COMPARISON OF ANOPHELES LITORALIS AND LUDLOWI WITH ANOPHELES SUNDAICUS RODENWALDT, 1925

Although *litoralis* and *ludlowi* are almost certainly specifically distinct, their relation to the variety occurring in brackish-water fishponds in the Netherlands East Indies is not so clear. The East Indian form (described as *Myzomyia ludlowi* var. *sundaica*) was separated from the type species on the basis of the relative widths of certain spots on the female wing. The author gives the distribution of this variety as "The Major and Minor Sunda Islands from Roma to Sumatra, the peninsula of Malacca and surrounding islands and on the Andamans."

The specimens from the Philippines which he had for comparison were probably the true *ludlowi.* They were sent to him by Mr. Tiedeman, most of whose material was, I believe, obtained from fresh-water rivers in Pampanga Province, Luzon. The distinguishing wing characters, or at least the measurements, given by Rodenwaldt would apply almost equally well to either of the Philippine forms. In Table 1 are given comparative measurements for certain characters in *ludlowi, litoralis,* and a few specimens of what are presumably *sundaicus* from Singapore, obtained through the kindness of Dr. C. H. Yeager. It may be noted that the measurements of the costa and vein 5.1 agree fairly well with those given by Rodenwaldt. His averages for *sundaicus* (all specimens) were 56 per cent black in the costal measurement and 63.6 per cent black on vein 5.1, as compared with my averages of 57 and 58 per cent for the Singapore material; his averages for the Philippine *ludlowi* were 35 per cent and 31 per cent, respectively, as compared with my averages of 37 and 35 per cent for *ludlowi* and 38 and 44 per cent for *litoralis.* (Compare figs. 1, 2, and 3 of Plate 1 for the wings of the three species.)

An accessory sector white spot on the subcostal vein was found by Rodenwaldt only once in 150 specimens, while in my

TABLE 1.—*Measurements of female palpal bands, wing spots, and vein 2.*[a] (*Speckle-legged species of Anopheles of the Pseudomyzomyia group.*)

	Anopheles litoralis (Luzon).	*Anopheles ludlowi* (Luzon).	*Anopheles sundaicus* (Singapore).	*Anopheles parangensis* (Mindanao).
Palpal apical bands:				
Number of measurements	46	25	12	11
Length of white plus dark—mm.	0.43	0.34	0.45	0.37
Ratio of black to white	0.58	[b] 0.60	0.69	0.73
Variation in ratio	0.39–0.94	0.29–1.00	0.37–1.00	0.54–0.86
Costal spots (see text fig. 1):				
Number of measurements	46	25	22	11
Per cent of black	38	37	57	26
Variation in per cent of black	26–50	29–48	47–65	21–32
Vein 5.1:				
Number of measurements	44	24	17	----------
Per cent of black	44	35	58	----------
Variation in per cent of black	35–60	30–49	43–85	----------
Vein 2:				
Number of measurements	25	25	23	9
Length of cell (average)—mm.	0.68	0.66	0.82	0.75
Length of stem (to crossvein)—mm.	0.60	0.60	0.49	0.58
Ratio of stem to cell	0.88	0.90	0.58	0.77
Variation in ratio	0.76–1.05	0.74–1.00	0.54–0.68	0.73–0.82

[a] Measurements were made from one wing per specimen except in *sundaicus* and *parangensis*, in which both wings were measured in most of the specimens. The measurements were made with an ocular micrometer at magnifications of 57 and 24.

[b] Does not include the additional black band which occurs in some specimens of *ludlowi* at the base of the apical joint.

TABLE 2.—*Measurements of palpal bands, wing spots, and vein 2.* (*Non-speckle-legged species of Anopheles of the Pseudomyzomyia group.*)

	Anopheles subpictus var. *indefinitus*.		*Anopheles subpictus* (India).	*Anopheles vagus* var. *limosus*.
	Brackish water.	Fresh water.		
Palpal apical bands:				
Number of measurements	20	47	22	36
Average length—mm.	0.36	0.34	0.45	0.33
Ratio of black to white	0.51	0.52	0.97	0.37
Variation in ratio	0.31–0.91	0.23–0.77	0.57–1.67	0.20–0.58
Costal spots:				
Number of measurements	20	20	21	20
Subapical white (length)—mm.	0.24	0.22	0.31	0.35
Subapical black—mm.	0.42	0.40	0.35	0.28
Subcostal white—mm.	0.19	0.19	0.38	0.40
Total length (average)—mm.	0.85	0.81	1.04	1.03
Per cent of black	49	48	34	27
Variation in per cent of black	37–65	38–57	24–42	16–37
Vein 5.1:				
Number of measurements	20	20	----------	19
Per cent of black	53	51	----------	44
Variation in per cent of black	44–61	39–75	----------	33–59

series it occurs in 74 out of 106 *litoralis* and in 17 out of 43 *ludlowi* (see Table 3). He states that three dark spots sometimes occur on vein 2.2, which has not been noted in the Philippine material. He also states that fringe spots between the veins are absent in *sundaicus* and this is true of all the Singapore specimens, while a light spot between veins 5.2 and 6

TABLE 3.—*Variation in occurrence of spots on female wing.*[a] *(Speckle-legged species of Anopheles of the Pseudomyzomyia group.)*

	Anopheles litoralis.		*Anopheles ludlowi.*		*Anopheles sundaicus.*		*Anopheles parangensis.*	
	Number.	Per cent.	Number.	Per cent.	Number.	Per cent.	Number.	Per cent.
Specimens examined[b]	88–106	------	43–45	------	10–12	------	7	------
White spots, basal third of costa:								
One	0	------	0	------	2	------	0	------
Two	81	------	45	------	9	------	7	------
Three	17	17	0	0	0	0	0	0
Sector spot on costa:								
Present	68	------	45	------	9	------	7	------
Incomplete[c]	6	6	0	0	3	25	0	0
Absent	23	24	0	0	0	0	0	0
Accessory sector spot on subcosta:								
Present	74	70	17	40	0	0	7	100
Absent	32	------	26	------	12	------	0	------
Accessory sector and sector spots on vein 1:								
Continuous	0	0	2	5	0	0	0	0
Slight black between[d]	27	------	7	------	2	------	3	------
Separated	79	------	34	------	10	------	4	------
Number dark spots on vein 1 under midcostal spot:								
One	0	------	2	------	0	------	0	------
Two	106	------	23	------	12	------	7	------
Three	0	0	20	44	0	0	0	0
Black spot at fork of vein 2:								
Absent	80	91	14	33	9	75	7	100
One to 3 dark scales	2	------	11	------	2	------	0	------
Patch of scales	*6	------	18	------	1	------	0	------
Fringe spot between veins 5.2 and 6:								
Present	34	35	30	68	0	0	7	100
Absent	63	------	14	------	10	------	0	------

[a] Variations sometimes occur in the markings of the wings of the same specimens. The characters were recorded from one wing on the same side (left) unless this one was in poor condition for examination.

[b] Some specimens were rubbed and for this and other reasons the characters were not recorded from the same number of specimens in all cases.

[c] With dark scales on anterior side and white scales on posterior side of costal vein.

[d] One to three dark scales; counted as a dark spot in next tabulation.

[*] Central spot on stem extended to fork; not a separate patch of scales.

occurs in about one-third (35 per cent) of the Philippine *litoralis* and two-thirds (68 per cent) of the *ludlowi.*

In the Singapore specimens the basal black spot of the costa is without white scaling on the anterior margin as in *ludlowi* and the ventral scaling of the legs is also more like *ludlowi* than *litoralis.*

TABLE 4.—*Variation in occurrence of spots on female wing. (Non-speckle-legged species.)*

	Anopheles subpictus var. *indefinitus.*				*Anopheles subpictus* (India).		*Anopheles vagus* var. *limosus.*	
	Brackish water.		Fresh water.					
	Number.	Per cent.	Number.	Per cent.	Number.	Per cent.	Number.	Per cent.
Specimens examined	82–95		52–60		22		50–53	
White spots, basal third of costa:								
One spot	13	14	4	7	0	0	0	0
Two spots	82		56		[a]8		50	
Three spots	0	0	0	0	14	64	0	0
Prehumeral white spot present	0		[b]0		21	95	0	
Sector spot on costa:								
Present	88		53		21		49	
Incomplete	1	4	4	12	1	5	1	2
Absent	3		3					
Accessory sector on subcosta:								
Present	37	40	21	38	1	5	7	14
Absent	55		35		21		43	
Accessory sector and sector spots on vein 1:								
Continuous [c]	20	21	9	16	12	55	7	11
Slight black between	19		15		10		9	
Separated	56		34		0		37	
Presector dark spot on vein 1:								
Absent	0		0		4	55	7	68
Shortened	8	9	3	6	8		29	
Long [d]	78		50		10		17	
Fringe spot between veins 5.2 and 6:								
Present	12	13	13	25	19	90	27	54
Absent	80		39		2		23	

[a] Prehumeral white spot absent in only one of these and the presector white spot absent in one. The others had one long spot, due to the absence of either the inner or outer accessory dark spots.

[b] Part of the *indefinitus* have white scales on the anterior edge of the costa near the base but not a complete white spot involving both sides of the vein.

[c] This is also the number with one dark spot on vein 1 under the midcostal spot except in one specimen of fresh-water *indefinitus* that had no dark spot.

[d] More than half the length of presector spot on costa.

A further important difference is found in the relative length of the forks and stem of vein 2. The ratio of the stem (measured from the supernumerary cross vein) to the posterior branch is 0.88 for *ludlowi*, 0.90 for *litoralis*, but only 0.58 for the Singapore *sundaicus* (see Table 1). Most of the illustrations of the wings of *sundaicus* given by Rodenwaldt also show the comparatively short stem.

The leaflets of the mesosome of the Singapore *sundaicus* are similar to those of *litoralis* and the Philippine *subpictus* so far as observed in the specimens examined, except for very slight differences in length of the longest leaflet, *sundaicus* being intermediate between these two species (Table 5).

The larvæ of the East Indian *ludlowi* and *subpictus* are said to be very similar except in the shape of the pecten, which Walch and Soesilo (1929) have recently used as a distinguishing character. Quite curiously their *ludlowi* type of pecten resembles the pectens of our *subpictus* (with short and long teeth of distinctly different length). If the character holds good it is also a distinction between *sundaicus* and *litoralis-ludlowi*.

In two mounted larval specimens from Singapore (loaned me by Doctor Yeager) both inner occipital hairs are bifid in each specimen (instead of the usual simple hair); the number of branches of the inner anterior thoracic hairs are 8–9 and 11–12 and in the middle hairs 11–10 and 13–14 (an average of 11 branches each); the antepalmate hairs on segment VI are all simple. The pecten of one of these specimens is similar to our material and not as given by Walch and Soesilo. Unfortunately, a sufficient number of authentic *sundaicus* larvæ are not available for a detailed comparison.

On biological grounds the differences between *sundaicus* and *litoralis* appear to be quite marked in certain characteristics. Along the coast of the bay on both sides of Manila are considerable areas of salt-water fishponds with a very large output of *Anopheles litoralis;* but, so far as I am informed, no serious trouble from malaria has ever been experienced in the vicinity of these breeding places. On the other hand, the East Indian *ludlowi* (= *sundaicus*), as is well known, is considered to be the principal carrier of malaria in Java and other of the Sunda Islands.

The salt content of the water most favorable for breeding evidently differs also. The Philippine form is found in abundance in water having a salt content of sea water or higher and

may or may not occur in brackish-water pools nearby. We have found it entirely replaced by *subpictus* in slightly brackish pools. The fishponds examined during the dry season have shown a specific-gravity reading equivalent to from 3.1 to 3.6 per cent salt or about equal to that of sea water. Larvæ of *litoralis* have also been taken in large numbers in partially concentrated pools connected with salt evaporation beds and containing from 4.2 to 7.4 per cent salt.[6] In the highest concentration full-grown larvæ and pupæ were collected in algal mats and adults emerged normally from these specimens.

In comparison with these records, the East Indian form is reported to thrive best at a salt percentage from 1.2 to 1.8 and to disappear when the salt content goes above 3 per cent (Rodenwaldt and Essed, 1925, and van Breemen, 1930). The Java salt-water *subpictus* is said to breed at higher salt percentages and this is just the reverse of the habits of the Philippine forms since our salt-water *subpictus* is limited to brackish water.

In regard to the nomenclature of these species, the least confusing solution would probably be to designate both *litoralis* and *sundaicus* as varieties of *ludlowi,* as Rodenwaldt has done with *sundaicus.* This would not be consistent, however, in view of the fact that the genitalia of *ludlowi* (a character that Rodenwaldt did not consider) are distinct and the differences in the female and larva are at least of the same order as those separating *subpictus* and *vagus.*

The similarity in the leaflets of the mesosome of *litoralis* and *sundaicus* would indicate a closer relationship between these two but is not necessarily final since the case of the Philippine *subpictus* shows that even in this group the leaflets may be quite similar in distinct species and such similarity is known of course in other groups. On the other hand, the difference between the two forms in the relative length of the first forked cell and its stem is very possibly specific. For this reason it has not seemed desirable to designate *litoralis* as a variety of *sundaicus* until a

[6] The salt concentration was estimated in most cases from specific-gravity readings. The highest percentage determination (7.4) was checked with a standard specific-gravity spindle and several of the others were checked by chlorine titrations made for me by Mr. R. H. Aguilar, of the Bureau of Science. The percentages obtained by the two methods were very close, provided the specific-gravity readings were properly adjusted for the temperature at which the spindles were calibrated.

further comparative study of the latter can be made. Moreover, a slight question still exists as to the correct name of the Malasian form. Christophers (1924) made *Anopheles flavescens* Swellengrebel (1921) a synonym of *ludlowi* as he thought it probably only a flavescent form and not a true local variety. The species was described from a specimen or specimens taken at Soerabaja, Java, and so far as I can ascertain has not again been encountered. It was said to be intermediate between *ludlowi* (= *sundaicus*) and *immaculatus* and the only *ludlowi*-like character mentioned was the amount of black scaling on vein 5.1 (three-fourths dark below the cross vein). All dark scaling was said to be bleached and the legs entirely pale. Since the legs were not speckled perhaps it could be considered a synonym of *subpictus* and thus avoid the necessity of substituting the name for *sundaicus*.

Reference should also be made to *Anopheles hatorii* Koidzumi, the Formosan form, which Yamada (1925) considered to be distinct from *ludlowi* after comparison with material in the British Museum. It appears from his description, however, that the specimens examined there were probably the salt-water form and not the true *ludlowi*. He states that the type specimen was in poor condition and that the comparison was made with specimens subsequently sent to the museum and bearing the identification labels of Banks and Ludlow.

For *A. hatorii*, he describes three dark spots on vein 1 under the midcostal area, a spot of dark scales at the fork of vein 2 and the mid and hind tarsi without basal banding, which indicate *ludlowi*. The leaflets of the mesosome of a male specimen obtained from the United States National Museum and labeled "*A. hatorii*, E. Formosa, V–1918" are, I find, similar to those of *ludlowi*. The long leaflet on each side is stout and S-shaped with a length of 56 μ.

While the two forms might be geographical varieties, Yamada's detailed description does not show distinct differences on which to separate them.

ANOPHELES PARANGENSIS Ludlow, 1914.

This species was described from very much speckled specimens sent from Parang, Mindanao, one of the southern islands. Miss Ludlow stated that it had not been received from any other locality and her mosquito collection, now in the United States National Museum at Washington, contains only two type specimens.

On a recent collecting trip to Mindanao (March and April, 1931), *parangensis* larvæ were taken in a fresh-water pool near the coast in Oriental Misamis Province, and a few adult specimens were reared from these. The larvæ were associated with *A. pseudobarbirostris* and *A. subpictus* var. *indefinitus* although the latter were somewhat differently distributed in the pool.

Rodenwaldt (1925 and 1926) has given a good description of the male, female, and larva from Celebes specimens. The description agrees very well with the Mindanao material with the possible exception of certain characters of the male genitalia, particularly the bulbous membrane with modified leaflets on the mesosome and the outer blunt spines on the harpagones noted in the Mindanao specimens. These were not mentioned by Rodenwaldt but may have been merely overlooked.

The principal characteristics of the species, based on the Mindanao material, are summarized below:

Female.—Sixth vein of wing (Plate 2, fig. 4) with three dark spots;[7] a wide fringe spot between veins 5.1 and 5.2 (in addition to the usual fringe spots at the tips of the longitudinal veins and between veins 5.2 and 6); subapical costal dark spot very short, averaging about one-fourth of the distal costal area and similar in this respect to the Philippine *vagus;* a prominent accessory sector spot on the subcosta in all specimens; two dark spots on vein 1 under midcostal spot, the end of the outer one even or nearly even with the distal end of the mid-costal spot; two white interruptions on basal third of costa and extreme base of costa usually white for a short distance.

Legs much speckled, the light scales forming distinct intermediate bands on the first three tarsal segments of the hind legs and usually one band in the middle of the 4th segment; tarsal segments of front legs broadly banded apically and basally; segments 1 to 4 of mid and hind tarsi with narrow apical bands and mid tarsal segments with a few basal white scales ventrally.

Palpi with the subapical dark band about three-fourths (0.73) the length of the apical white.

Male genitalia.—(Plate 3, fig. 5.) As noted by Rodenwaldt, who has described and figured the genitalia, these differ remarkably from the other species in the subgenus *Myzomyia.* The usual group of parabasal spines is absent and two unmodified

[7] The basal spot was said by Rodenwaldt to be lacking sometimes. Three dark spots on vein 6 occur very rarely in *A. ludlowi.*

hairs, one very long and one very short, occur in this area. On the inner face of the side piece near the basal ring is an expanded or spoon-shaped blade arising from a tubercle. Another short hair occurs near the base of the tubercle. In a freshly dissected specimen, examined before mounting, the spoon-shaped blade appears to be semimembranous toward the apex and the base is in the shape of a trough (Plate 3, fig. 5, *b*). It has hardly any resemblance to the stout spines found in the subgenus *Anopheles*. The principal lobe of the harpago (fig. 5, *c*) is extended into a fingerlike process bearing a flattened blade, split at the tip. A smaller outer lobe bears a short hair and a longer, stout, blunt spine, the latter double on each side in one of three specimens. The usual leaflets are lacking on the mesosome and in place of these a peculiar transparent bulbous membrane (not mentioned by Rodenwaldt) surrounds the end dorsally; that is, on the side toward the anal segment. Along each side of the membrane are a number of short, overlapping, modified leaflets, apparently fused basally. In fig. 5, *c*, Plate 3, the leaflets are shown in a single row, although after mounting and under higher magnification there appears to be a double layer of leaflets on each side.

Larva.—Clypeal hairs long and slender, usually simple (fig. 2, *e*); two specimens out of twenty-two with one of the inner hairs forked, one with an outer and one with a posterior hair forked;[8] anterior thoracic hairs more heavily branched than in *subpictus* or *ludlowi* with an average of fifteen or sixteen branches (fig. 3, *c*); thoracic palmate with an average of five hairlike branches; first abdominal palmate tuft typically developed, although small (fig. 4, *b*); those on the other segments unusually broad and often pigmented (fig. 5, *c*); tergal plates similar to *subpictus* (var. *indefinitus*), or slightly broader. Pecten (fig. 6, *e*) with about nine short and four long teeth, the short teeth at the lower end hardly more than one-third the length of the long teeth.

The long hairs in the pleural hair[9] group of the prothorax consist of two simple hairs and one feathered hair; the group on the mesothorax with one long simple hair and one sparsely

[8] The clypeal hairs of the Celebes specimens, especially the outer, appear to have more of a tendency toward branching. According to Rodenwaldt they are often bifurcated or may have from two to three side branches.

[9] The term used by Puri (1928) to designate the paired ventrolateral groups of hairs of the thorax, one pair on each of the three segments.

feathered; the mesothorax with two long feathered hairs. Basal tubercle on the pro- and mesothorax with a large sharp spine; a shorter one on the metathorax. Other larval characters are shown in table 6.

The larva of *parangensis* is closest to the Philippine form of *subpictus* in the characters generally employed for identification, but the two can usually be separated readily enough by the shape of the first palmate hairs and the anterior thoracic hairs, as stated by Rodenwaldt. A few specimens, however, were found to be intermediate and in these cases positive identifications could be made by the presence of feathered hairs in the pleural hair groups of the pro- and mesothorax. In *subpictus* (as well as *vagus* and *ludlowi*) one of the long hairs in each group may be 2- or 3-branched toward the tip, but none of the hairs in either group is feathered.

The differences in the larval and genitalic characters raise the question as to the affinities of this species. On the basis of the pleural hairs it would fall into Group II of Puri's classification, with *maculatus, philippinensis,* etc. (group *Neocellia* of Christophers), instead of Group III containing *subpictus, vagus,* and *ludlowi* (group *Pseudomyzomyia* of Christophers). The adults of *parangensis,* however, have narrow scales on the mesonotum and two or three large prosternal hairs, as in *Pseudomyzomyia.* Most of the other adult and larval characters are also typical of the group, and I think it probably correct to assume that it comes nearest to *Pseudomyzomyia,* in spite of the pleural hairs and the freakish male hypopygium.

ANOPHELES SUBPICTUS var. INDEFINITUS Ludlow 1904. (Anopheles indefinitus.)

It is somewhat unfortunate that the name *indefinitus* should have to be resurrected since it has been used in the literature to designate both *subpictus* and *vagus.* Nevertheless, a recent examination of the type material in the United States National Museum leaves little doubt that at least two of the four specimens bearing the type label are of the *subpictus* form; the other two are too badly damaged to be identified. In the two better specimens the palpal subapical black bands are from 0.6 to 0.8 as long as the apical white, while the subapical black costal spots of the wings are wider than the white spots on either side. Measurements of the two specimens made for me by Mr. C. T. Green gave 50 per cent and 47 per cent as the proportion of black in the total length of the three costal spots. These percentages fall outside the range of variability for *vagus* variety

(Table 2) but are very close to the average for the Philippine *subpictus* specimens. This confirms the synonymy previously given by Christophers (1916 and 1924).

Through the kindness of Maj. G. Covell who has sent me a good series of *subpictus* from Larkana, India, I have been able to compare the Philippine form with the type form. As noted in connection with the descriptions below, the differences in the palpal, wing, and especially the genitalic characters are of about the same order as those distinguishing the Philippine *subpictus* and *vagus*. While I believe that *indefinitus* is a distinct species and should be so treated, I have retained it as a variety for the present in order to avoid the confusion resulting from the previous misapplication of the name.

Female (*var. indefinitus from fresh water*).—Palpal bands variable (see Table 2), the subapical dark averages about one-half (0.52) the length of the apical white; subapical dark spot on costa of wing (Plate 2, fig. 2) as wide as and usually distinctly wider than the white spot on either side; subcostal white spot usually shorter than subapical white; dark presector spot on vein 1 usually more than half as wide as the costal spot above it; two, sometimes one, white interruptions on the basal third of the costa, formed by the humeral white spot which is invariably present and the presector white spot which is usually present; scattered white scales frequently occur along the anterior edge of the base of the costa but no specimens noted with a complete prehumeral white spot similar to that in the type form; fringe spot between veins 5.2 and 6 present in 25 per cent of the specimens. Hind tarsal segments with apical but not basal white banding; mid tarsi with narrow apical bands on segments 1 to 3 and usually with a few basal pale scales ventrally on segments 2 to 4.

Fore tarsi of male with a narrow though usually fairly distinct basal and apical band at tarsal joint 3–4.

Male genitalia.—Mesosome with from 6 to 13 leaflets on each side (Plate 3, fig. 2, and Plate 4, fig. 2), much shorter than in *vagus* [10] and with less difference in length between the indi-

[10] Not similar to those of *vagus* as stated by C. M. Urbino (see footnote 2). He also states that fresh-water *subpictus* as well as salt-water *ludlowi* and *vagus* have non-serrated leaflets and differ from salt-water *subpictus* in this respect. However, when properly mounted, serrated leaflets are to be seen in all of these forms.

vidual leaflets, as in *litoralis;* most of the leaflets flattened and bladelike, and with serrations on the straight side.

Larva.—Clypeal hairs (fig. 2, *b*) usually simple but occasionally forked (as occurs in nearly all species of this group), the outer and posterior hairs from one-half to three-fourths the length of the inner and the posterior extend about half their length beyond the base of the inner; thoracic palmate undeveloped; palmate of abdominal segment I (fig. 4, *a*) with an average of 7.6 leaflets, partly developed, the leaflets spread, somewhat broadened, and with a terminal filament; leaflets of other palmate tufts (fig. 5, *d*) usually wider and longer than in the Philippine *vagus* (noted by C. M. Urbino); ratio of filament to branch (leaflets of palmate IV) about 0.85, total length about 0.1 millimeter; lateral hairs of abdominal segment IV usually 3-branched, seldom two as in *vagus;* pecten (fig. 6, *b*) with four or five long teeth and eight or so short teeth, the latter about one-half the length of the former, especially on the lower end.

The Philippine species has sometimes been identified as *Anopheles subpictus* var. *malayensis* Hacker, 1921, a variety originally separated from the type form on the basis of a greater variability in the palpal banding. The two may be distinct but in any event the name *indefinitus* antedates this and should be applied to the local species.

I have recently had an opportunity to examine fourteen larvæ of var. *malayensis* from the Federated Malay States, for which I am indebted to Dr. A. N. Kingsbury and Mr. E. P. Hodge, of the Institute for Medical Research, Kuala Lumpur. Certain slight differences in comparison with *indefinitus* were observed, as follows:

Anterior submedian thoracic hairs somewhat more branched, the inner with an average of 17.5 branches compared with 13.2 in *indefinitus* and the middle hairs with an average of 15.8 compared with 12.2. The range for the inner was from 11 to 21 and for the middle hair, from 11 to 20. Palmate I more typically developed than in *indefinitus* and similar to *parangensis* in this respect; average number of leaflets 10.5 (range 8 to 13) compared with the average of 7.6 in *indefinitus.* The leaflets of palmate IV appear to be somewhat larger, with a total length of filament and blade of about 0.12 millimeter and the filament approximately equal to the blade in length.

Other larval characters are similar to those of *indefinitus* as given in Table 6 and the pecten has long and short teeth of distinctly different lengths.

The leaflets of the male mesosome, in two specimens, are more nearly similar to *indefinitus* than to the type form; the apical leaflet slightly longer (42 μ long) and narrower than in *indefinitus*.

Yamada (1925) considered both *indefinitus* and *vagus* to be synonymous with *Anopheles formosaensis II* Tsuzuki, 1902. The name *formosaensis*, however, is preoccupied and the combination "*formosaensis* II" appears to be invalid. Judging from some of the characters given by Yamada for the Formosan specimens it is probable that they were of the *indefinitus* type (as defined here), rather than *vagus*.[11] The characters that indicate *indefinitus* are: Subapical dark band on the female palpi from one-half to two-thirds the width of the apical white, subcostal white spot of the wing slightly shorter than the subapical dark spot, presector dark spot on vein 1 three-fifths the length of the costal spot above it and the basal dark spot on the costa (inner accessory dark spot) with white scales on the anterior margin. The banding of the hind tarsi may also indicate *indefinitus*, in which basal white bands are absent as noted by Yamada for *formosaensis II*. Their occurrence on *vagus*, however, is very irregular.

ANOPHELES SUBPICTUS Grassi, 1899. (Type form.)

The series of specimens from Larkana, Sind, India, furnished by Major Covell, show a number of differences from the Philippine material as follows: Palpal black bands wider, about equal in width to the apical white; subapical black costal spot of wing (Plate 2, fig. 3) shorter, usually less than the length of the white on either side; basal third of costa mostly white scaled, usually divided into three white areas consisting of presector, humeral, and prehumeral white spots, the latter sometimes continuous with the humeral spot. The prehumeral white spot is absent in only one of twenty-two specimens and the presector white spot absent in one. A fringe spot between veins 5.2 and 6 is present in all except two specimens and is sometimes continuous with the fringe spot opposite 5.2.

[11] Dönitz (1903, p. 234) thought that a specimen of *formosaensis II*, received from Tsuzuki, also had a greater likeness to *A. rossi* than to *A. vagus*.

TABLE 5.—*Measurements of the longest leaflet of the mesosome in several species of Anopheles.*[a]

Species.	Locality.	Number measured.	Average length (microns) and standard deviation.	Variation (microns).
Anopheles litoralis	Philippine Islands	19	42 ± 1.0	31–47
Anopheles ludlowi	do	9	53 ± 1.7	47–64
Anopheles sundaicus	Singapore	5	39	37–42
Anopheles subpictus	India	7	57	51–59
Anopheles subpictus var. *indefinitus*:				
Brackish water	Philippine Islands	18	36 ± 0.6	31–40
Fresh water	do	21	36 ± 0.7	28–40
Anopheles vagus	Java	3	72	71–75
Anopheles vagus var. *limosus*	Philippine Islands	15	68 ± 1.0	61–75

[a] Measured with an ocular micrometer at a magnification of × 425.

Male genitalia.—The leaflets of the mesosome (Plate 4, fig. 5) are somewhat intermediate between *vagus* and *indefinitus* but nearer to those of *vagus*. The first leaflet is long, stout, and tapered, with an average length of 57 μ compared with 68 μ in the Philippine *vagus* and 36 μ in *indefinitus*. As shown by the illustration, it differs slightly in shape from that of *vagus* and quite decidedly from that of *indefinitus*. There may also be more short leaflets than in *vagus*. As in all the other members of the group some of the leaflets are serrated, the long one on the basal half. Although the two Philippine species are readily identified by the shape and length of the leaflets, I should expect more difficulty in distinguishing *vagus* from the type form of *subpictus*, except possibly by actual measurement.

ANOPHELES SUBPICTUS FROM BRACKISH WATER

In two places near Manila are certain brackish-water ponds in which *subpictus* type of larvæ giving rise to adults with unspotted legs can usually be found. The water in these ponds appears to be seep water or overflow water from nearby fishponds and salt beds, diluted by rain water, and there is considerable fluctuation in the salt content. Occasionally, a mixture of *subpictus* and *litoralis* larvæ have been taken in one of the ponds, but at other times "pure cultures" of *subpictus* larvæ occur in the brackish water and only *litoralis* larvæ just across a dike or embankment in more salty water.[12]

[12] These records apply to the dry season. During the rainy season the fishponds and salt ponds become much diluted. Breeding of *litoralis* appears to be reduced and that of *subpictus* becomes more general.

Subpictus larvæ have not as yet been taken in water with a salt content as high as sea water, the highest salt percentage recorded for them being 2.8. This was in a slowly drying pool and the larvæ were much less abundant than they had been three weeks previously when the water showed only 1.4 per cent salt.

In fresh-water breeding places *indefinitus* larvæ are found in association with one or more of several other common species such as *fuliginosus, barbirostris,* or *ludlowi.* Its occurrence in pure cultures in a different type of breeding place therefore gives the impression of a possibly distinct biological race. In the present study the material from the two sources has been considered separately, and the comparative tabulation of larval and adult characters shows certain variations between the two forms, several of which are at least of statistical significance and others that might be so in larger series.

It may be noted in Table 4 that the fresh-water form gave a larger proportion of specimens with a fringe spot between veins 5.2 and 6 and a slightly larger proportion with incomplete or absent costal sector spots. Statistically significant differences (as shown by the relation to the standard deviation) were found in certain of the larval characters (Table 6) as follows:

Outer occipital hair; 32 per cent 5-branched in the salt-water larvæ compared with 48 per cent in the fresh-water larvæ—a difference of 0.16 ± 0.062.

Thoracic palmate hair; 71 per cent 3-branched compared with 38 per cent in the fresh-water larvæ—a difference of 0.33 ± 0.084.

Palmate I; 15 per cent with 5 or fewer branches compared with 3 per cent—a difference of 0.12 ± 0.032.

Antepalmate VII; 3 per cent 4-branched compared with 13 per cent—a difference of 0.10 ± 0.03.

The measurements of certain characters shown in Tables 2 and 5 are, however, almost identical and no decided characteristics that would justify their separation have as yet been noted. Variations somewhat comparable to those given above may sometimes occur in different broods or lots of what are clearly the same species.

ANOPHELES VAGUS var. LIMOSUS var. nov.

The separation of the Philippine form of this species as a variety of the type form from Java seems justified on the differences in the posterior clypeal hairs of the larvæ. The description and illustrations of Swellengrebel (1919) and others

show these hairs to be much closer together than the inner anterior clypeals and placed well forward on the clypeus. Two or three larval specimens recently received from Java through the kindness of Doctor Soesilo show this placement clearly. The illustration (fig. 2, *d*) was drawn from one of these. In variety *limosus* the postclypeal hairs arise much farther back and are nearly in line with or sometimes slightly closer together than the inner anterior clypeals. Sufficient material for a more detailed comparison of the larvæ or adults of the type form is not available at the present time.

Female.—Palpal black band narrower than in var. *indefinitus* in the majority of specimens but is variable and not by itself a dependable diagnostic character; proboscis without the white spot just back of the flabella that is said to occur in the type form; subapical black costal spot of wing (Plate 2, fig. 1) almost always shorter than one, usually both, of the adjoining white spots and frequently very much reduced, averaging only slightly more than one-fourth of the total area of the three spots; subcostal white spot usually as long as or longer than subapical white; accessory sector spot on subcosta sometimes present; sector spot and accessory sector spots on vein 1 continuous in 11 per cent of the specimens; presector black spot on vein 1 less than half as long as the costal spot above it in two-thirds (68 per cent) of the specimens, sometimes entirely absent, as compared with var. *indefinitus* in which this spot is very seldom less than half as long as the costal spot; two white basal costal interruptions present in all specimens; basal dark spot seldom with white scales on anterior margin; fringe spot between veins 5.2 and 6 in 54 per cent of the specimens.

Fore tarsi of male usually without a basal white band on segment 4 and sometimes without apical band on segment 3 (similar in this respect to the banding in the type form as shown by Rodenwaldt, 1922).

Male genitalia.—Leaflets of the mesosome (Plate 3, fig. 4, and Plate 4, fig. 4) differ in size and shape from any of the other Philippine species in this group but appear to be similar to those of the type form of *vagus* from Java and as described by Christophers (1915) for Indian specimens. The group on each side consists usually of four stout, straight leaflets, the first one very long, the others progressively much shorter. In addition there are usually one or two, sometimes more, short irregular spikes at the base and occasionally a longer slender leaflet. The longest leaflet averaged 68 μ in length and the

TABLE 6.—*Comparative branching of larval hairs and measurements of palmate leaflets in several species of Anopheles.*

	Anopheles litoralis.		*Anopheles ludlowi.*		*Anopheles parangensis.*		*Anopheles subpictus* var. *indefinitus.*				*Anopheles vagus* var. *limosus.*	
							Brackish water.		Fresh water.			
	Number.	Per-cent.	Number.	Per-cent.	Number.	Per-cent.	Number.	Per-cent.	Number.	Per-cent.	Number.	Per-cent.
Larval specimens examined [a]	129		99		22		68		66		96	
Inner occipital hair:												
Variation (in branching) [b]	1–3		1–3		1–2		1–4		1–3		1–3	
Usual	1	96	1	96	1	88	1	98	1	96	1	95
Outer occipital hair:												
Variation	1–5		2–7		3–5		3–6		3–7		3–9	
Usual	3–2	89	4–5–3	91	4–5–3	100	4	46	5	48	5	39
	3 or less	97	4 or more	77			5	32	4	31	6	36
Anterior thoracic hairs:												
Inner	2–11		8–16		12–20		7–16		9–16		10–18	
Average	6.7		12.3		16.7		11.5		13.2		13.4	
Usual	8 or less	91	10 or more	92	15 or more	85	9–14	88	10–15	88	11–17	92
Middle	2–10		8–14		12–19		6–15		9–16		9–17	
Average	6.0		10.1		15.4		11.3		12.2		12.4	
Usual	8 or less	91	9 or more	94	14 or more	84						
Thoracic "palmate" hair:												
Variation	1–4		2–6		3–7		2–5		2–5		1–6	
Average	2.3		3.6		5.0		3.2		3.7		2.9	
Usual	3–2	83	4–3	67			3	71	4	43	3	53
	3 or less	99	4 or more	52			4	19	3	38	2	25
Abdominal palmate, segment I:												
Variation	3–9		2–6		8–12		4–11		5–11		2–8	
Average	5.3		3.2		10.5		7.0		7.6		5.0	
Usual	5–6–4	77	3–4–2	93	11–10	68	7–8–6	72	8–7–6	74	5–6–4	80
	6 or more	43	5 or less	99			6 or more	85	6 or more	97	5 or less	71

Antepalmate hairs:												
Segment II	2–5		2–6		3–4		3–6		3–6		2–5	
Usual	3	76	3–4	88	3	76	4–5	80	4–5	81	3	79
Segment III	2–4		2–5		3–4		3–5		2–6		2–4	
Usual	3	98	3	89	3	95	3	84	3	81	3	95
Segments IV and V	1–3		1–2		1		1–2		1–2		1–2	
Usual	1	98	1	99	1	100	1	96	1	99	1	99
Segment VI	1–3		1–2		1–3		1–3		1–3		1–4	
Usual	1	53	1	94	1	98	1	81	1	90	2	41
	2	34									3	36
Segment VII	2–5		1–4		3–5		1–4		2–4		2–7	
Usual	3	92	3	80	4–5	88	3	90	3	84	4	46
							4	3	4	13	3	33
Lateral abdominal hairs:												
Segment IV	2–6		2–6		2–4		2–4		2–4		2–4	
Usual	3	85	4	50	3	95	3	87	3	85	2	55
	2	9	3	44			2	9	2	8	3	44
Segments V and VI	2–5		2–5		2–4		2–4		2–4		2–4	
Usual	3	83	3	74	3	90	3	83	3	88	3	70
Measurements of leaflets of palmate IV:												
Number of measurements	50		50		30		50		50		50	
Filament, average length—mm	0.036		0.031		0.053		0.047		0.047		0.023	
Blade, average length—mm	0.039		0.035		0.041		0.051		0.055		0.041	
Total, average length—mm	0.075		0.066		0.094		0.098		0.102		0.064	

[a] Both hairs in each pair were counted in the majority of specimens, except the anterior thoracic hairs and the thoracic palmate hairs which were recorded for only a part of the specimens.

[b] Simple hairs indicated by figure "1."

measurements made of the four main leaflets in a typical group were 67–51–36–21 μ.

When the mesosome is separated from the hypopygium and mounted separately the leaflets frequently show fine serrations along the sides as in fig. 4, Plate 4. (See footnote 10.)

Larva.—Clypeal hairs (fig. 2, *c*) usually simple, sometimes forked, the outer short, about one-third the length of the inner; the posterior slightly longer than the outer and normally extend only a short distance beyond the base of the inner but not beyond the front margin of the clypeus; they are placed well back on the clypeus and are as widely or nearly as widely separated as the inner hairs. In the type form the posterior hairs are only about one-third their own length back of the inner and their bases are much closer together (fig. 2, *d*). Anterior submedian thoracic hairs and antepalmate hairs of segments III, IV, and V similar to var. *indefinitus;* thoracic palmate with an average of about three (2.9) hairlike branches; palmate I with an average of five hairlike or slightly broadened branches (fig. 4, *d*); antepalmate hairs of segment II usually 3-branched; those of segment VI usually 2- or 3-branched instead of simple as in other members of the group; about half (55 per cent) of the lateral abdominal hairs of segment IV 2-branched (instead of the normal three)—one or both of the hairs 2-branched in 74 per cent of the individual specimens; average ratio of filament to blade of the leaflets of palmate IV about 0.56; leaflets (fig. 5, *b*) narrower than and about two-thirds (64 per cent) the total length of those in var. *indefinitus;* pecten with short and long teeth of distinctly different lengths (fig. 6, *d*).

Type female.—Reared from larva collected at Balintawak, Rizal, Luzon, January 15, 1929.

The typical breeding place of the species is a small muddy unshaded pool without aquatic vegetation.

Summary of the principal distinguishing characters of the Philippine species of the Pseudomyzomyia group.

ADULTS

1. Legs speckled ..... 2.
   Legs not speckled ..... 4.
2. Female; sixth vein of wing with two dark spots, no pale fringe spot between forks of vein 5, subapical black costal spot of about the same length as the white areas on either side.
   Male genitalia of normal *Myzomyia* type with a group of four or five spines in the parabasal area of the side piece..... 3.

Vein 6 with three dark spots; pale fringe spot between forks of vein 5; subapical costal black spot very short.

Side piece of male genitalia without the normal group of parabasal spines; a long and a short unmodified hair in this area and internally a large spoon-shaped organ arising from a tubercle; mesosome with a bulbous membrane bearing modified leaflets; claspette (harpago) with a long fingerlike extension..... *A. parangensis.*

3. Sector spot of wing costa frequently absent or incomplete; basal dark spot of costa usually with white scaling on anterior margin, sometimes forming a complete prehumeral white spot; two dark spots on vein 1 under mid-costal area; vein 2 without a separate patch of dark scales at fork; legs usually yellowish scaled ventrally and segments 3 and 4 of mid tarsi, often segment 2, with narrow basal as well as apical pale bands. Fossa of mesonotum with scattered broad flat scales (about six to ten in number).

Mesosome with eight to fourteen leaflets, subequal in length, some of them flattened and blade-shaped, the longest about 42μ.... *A. litoralis.*

Costal sector spot present; basal dark spot of costa without white scaling on anterior margin; three dark spots on vein 1 under the midcostal area and a dark patch of scales at fork of vein 2 frequently present; legs, except for speckling, mostly dark scaled ventrally as well as dorsally; segments of mid and hind tarsi usually without basal pale bands. Apical white palpal band frequently divided into two by an additional narrow black band at the base of the apical segment.

Mesosome with three or four main leaflets on each side besides a few short spikes; the first leaflet stout, S-shaped and broadest near base with prominent serrations, the next two or three leaflets progressively shorter; length of longest about 53 μ..... *A. ludlowi.*

4. Female wing with subapical costal black spot usually distinctly shorter than the white spots on either side, particularly the subcostal spot; presector dark spot on vein 1 usually less than half as long as the costal spot above, sometimes absent; costal dark spot at base of wing without white scales on anterior margin; preapical palpal black band narrow, averaging about one-third the length of the apical white.

Mesosome with four or five stout leaflets and one or more short spikes on each side; the first leaflet straight and very long, the next three or four progressively shorter; length of long leaflet about 68 μ.

A. vagus var. *limosus.*

Subapical costal black spot usually as long as or longer than the white spot on either side; presector dark spot on vein 1 usually more than half the length of the costal spot above costal dark spot at base of wing often with white scaling on anterior margin; preapical palpal black band averaging about one-half the length of the apical white.

Mesosome with six to thirteen leaflets on each side, short and similar to *litoralis* in shape; length of longest about 36 μ.

A. subpictus var. *indefinitus.*

LARVÆ

1. Outer clypeal hairs one-half or more, the length of the inner..... 2.
   Outer clypeal hairs short, about one-third the length of the inner; palmate of first abdominal segment hairlike; one or both lateral hairs of segment IV 2-branched and antepalmate hair of segment VI, 2- or 3-branched in many of the specimens; pecten usually with short and long teeth of distinctly different lengths.
   A. vagus var. *limosus.*
2. Palmate of segment I with more- or less-developed leaflets terminating in filaments; short teeth of pecten usually about one-half, or less, the length of the long teeth..... 3.
   Palmate I hairlike or, if the hairs are slightly broadened, without differentiated filaments; short and long teeth of pecten of about the same length ..... 4.
3. Palmate I usually not fully developed; anterior thoracic hairs usually with less than fifteen branches; pleural hair groups on pro- and mesothorax without feathered hairs..... *A. subpictus* var. *indefinitus.*
   Palmate I small but typically developed; anterior thoracic hairs usually with fifteen or more branches; pleural hair groups on pro- and mesothorax each with one feathered hair..... *A. parangensis.*
4. Lateral hairs of abdominal segments IV to VI with the first branches arising some distance from the base, the hair on segment IV frequently 4-branched. In the majority of specimens the outer occipital hair has four or more branches, the anterior thoracic hair more than nine branches and the antepalmate hair of segment VI is simple ..... *A. ludlowi.*
   Lateral hairs of abdominal segments IV to VI branched near the base, usually with three branches. The outer occipital hair has less than four branches and the anterior thoracic hairs less than nine branches in the majority of specimens while the antepalmate hair of segment VI is bi- or tri-fid about half the time..... *A. litoralis.*

GENERAL SUMMARY

Five anopheline species of the *Pseudomyzomyia* group, commonly referred to as the *rossi-ludlowi* group, occur in the Philippines. Their principal distinguishing characters are given, together with comparative observations on related species and the conclusions reached in regard to questions of nomenclature.

Two speckle-legged forms that have formerly been included under the name *Anopheles ludlowi* Theobald, are shown to be specifically distinct and to differ from the important East Indian species, *Anopheles sundaicus* (also called *ludlowi*). The name *ludlowi* is restricted to the form that, in the Philippines, appears to breed exclusively in fresh water and a new name, *Anopheles litoralis*, is proposed for the local salt-water breeder.

The leaflets of the mesosome of *A. ludlowi* are distinct from those of the other members of the group, while the leaflets of *sundaicus* and *litoralis* (as well as the Philippine *subpictus*) are more nearly alike. *Anopheles sundaicus* differs from both *ludlowi* and *litoralis* in the relative lengths of the stem and forks of wing vein 2, and, as shown by Rodenwaldt for *ludlowi*, in the proportion of black- to white-scaled areas on the costa and vein 5.1, as well as in certain other wing markings.

Although *sundaicus* is an important carrier of malaria in Java and elsewhere, the salt-water form in the Philippines is not known to be of any importance in this respect. These two species evidently differ also in regard to the concentration of salt required to produce the most favorable breeding conditions. *Anopheles sundaicus* is said to thrive best in water containing less than 2 per cent salt, while *litoralis* is found breeding most prolifically in water of about the salinity of sea water (from 3 to 4 per cent) or higher. They have been collected in water containing as high as 7.4 per cent salt (about 27 per cent of saturation).

The Philippine form of *Anopheles subpictus* Grassi differs from the type form from India in the leaflets of the mesosome as well as in certain wing characters. While the evidence indicates that it is a distinct species, it is retained for the present as a variety, *Anopheles subpictus* var. *indefinitus* Ludlow, to avoid the confusion that might otherwise arise due to the previous misapplication of the name to *Anopheles vagus*.

Larvæ of var. *indefinitus* are found in brackish as well as fresh water. Although minor variations occur in material from the two sources, no distinctive differences sufficient to justify their separation have been observed.

The Philippine form of *Anopheles vagus* is separable from the East Indian type form on the position of the posterior clypeal hairs of the larva. It is therefore described under a new varietal name, *A. vagus* var. *limosus*. The leaflets of the mesosome of this variety are distinct from those of the other Philippine species.

Anopheles parangensis, a very much speckled species with a southern distribution, differs from the other members of the group, especially in the thoracic pleural hairs of the larva and in the male genitalia. The latter, as shown by Rodenwaldt, are unique in that they lack the typical parabasal spines but possess

a large spoon-shaped organ on the side pieces and a fingerlike extension of the claspettes (harpagones). A peculiar membrane with modified leaflets, that has not previously been described, is found to be attached to the mesosome.

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ERRATA

In a previous article on the "Philippine varieties of *Anopheles gigas* and *Anopheles lindesayi*," Philip. Journ. Sci. 46 (1931) 751–757, the figure numbers for the illustrations of the leaflets of the mesosome (Plate 2) have been reversed. As now numbered, fig. 3 should read "*Anopheles lindesayi* var. *benguetensis*" and fig. 4, "*Anopheles gigas* var. *formosus*."

For "antipalmate" on pp. 752 and 755 read antepalmate.

Attention may also be called to the fact that, in the illustrations of the wings of the two species, some of the white spots have not been reproduced clearly, especially the fringe spot between veins 5.2 and 6 in fig. 1 (var. *formosus*), the long white spot on the apical half of vein 6 and the small spot in the center of vein 2.1. Vein 5.2, which appears to be somewhat pale is actually dark.

In fig. 2 (var. *benguetensis*) all of the white spots with the exception of the fringe spots at the ends of veins 4.2 and 6 are considerably more contrasting in the original than they appear in the illustration.

ILLUSTRATIONS

Plate 1. Female Wings

Fig. 1. *Anopheles ludlowi,* with costa of another specimen showing two spots on vein 1 under the midcostal spot and an accessory sector spot on the subcosta.
2. *Anopheles litoralis,* with costa of another specimen showing an accessory sector spot on the subcosta, a complete sector spot and a patch of white scales on the anterior margin of the basal black spot.
3. *Anopheles sundaicus.*

Plate 2. Female Wings

Fig. 1. *Anopheles vagus* var. *limosus,* with costa of another specimen showing a very short subapical dark spot, one dark spot on vein 1 under the midcosta, and a short presector dark spot on vein 1.
2. *Anopheles subpictus* var. *indefinitus.*
3. *Anopheles subpictus;* type form from India. (This specimen lacks the fringe spot usually present between veins 5.2 and 6.)
4. *Anopheles parangensis.*

Plate 3

Fig. 1. *Anopheles litoralis;* leaflets of mesosome (ædeagus).
2. *Anopheles subpictus* var. *indefinitus;* leaflets of mesosome.
3. *Anopheles ludlowi;* leaflets of mesosome, showing on the right side the typical shape of the long leaflet.
4. *Anopheles vagus* var. *limosus;* leaflets of mesosome.
5. *Anopheles parangensis; a,* base of side piece; *b,* expanded organ on the side piece, drawn from an unmounted specimen; *c,* mesosome and claspette.

Plate 4

Leaflets from one side of mesosome, at higher magnification, to show shape and serrations. (Originally drawn at a magnification of × 2,500.)

Fig. 1. *Anopheles litoralis.*
2. *Anopheles subpictus* var. *indefinitus.*
3. *Anopheles ludlowi.*
4. *Anopheles vagus* var. *limosus.*
5. *Anopheles subpictus;* type form from India.

TEXT FIGURES

FIG. 1. Terms employed to designate the costal wing spots. Most of the names have been adapted from those used by S. R. Christophers and others.

2. Larval clypeal hairs; *a, Anopheles litoralis; b, Anopheles subpictus* var. *indefinitus* (also similar to *A. ludlowi*); *c, Anopheles vagus* var. *limosus; d, Anopheles vagus*, type form from Java; *e, Anopheles parangensis.*

3. Anterior submedian thoracic hairs; *a, Anopheles litoralis; b, Anopheles subpictus* var. *indefinitus* (also similar to *A. ludlowi* and *A. vagus* var. *limosus*); *c, Anopheles parangensis.*

4. Palmate hairs of first abdominal segment; *a, Anopheles subpictus* var. *indefinitus; b, Anopheles parangensis; c, Anopheles ludlowi; d, Anopheles vagus* var. *limosus; e, Anopheles litoralis.*

5. Leaflets of palmate hairs from abdominal segment IV (*a* to *d*) and lateral hairs from same segment (*e* and *f*); *a, Anopheles litoralis; b, Anopheles vagus* var. *limosus; c, Anopheles parangensis; d, Anopheles subpictus* var. *indefinitus; e, Anopheles litoralis*, lateral hair; *f, Anopheles ludlowi.*

6. Pectens of eighth abdominal segment; *a, Anopheles litoralis; b, Anopheles subpictus* var. *indefinitus; c, Anopheles ludlowi; d, Anopheles vagus* var. *limosus; e, Anopheles parangensis.*

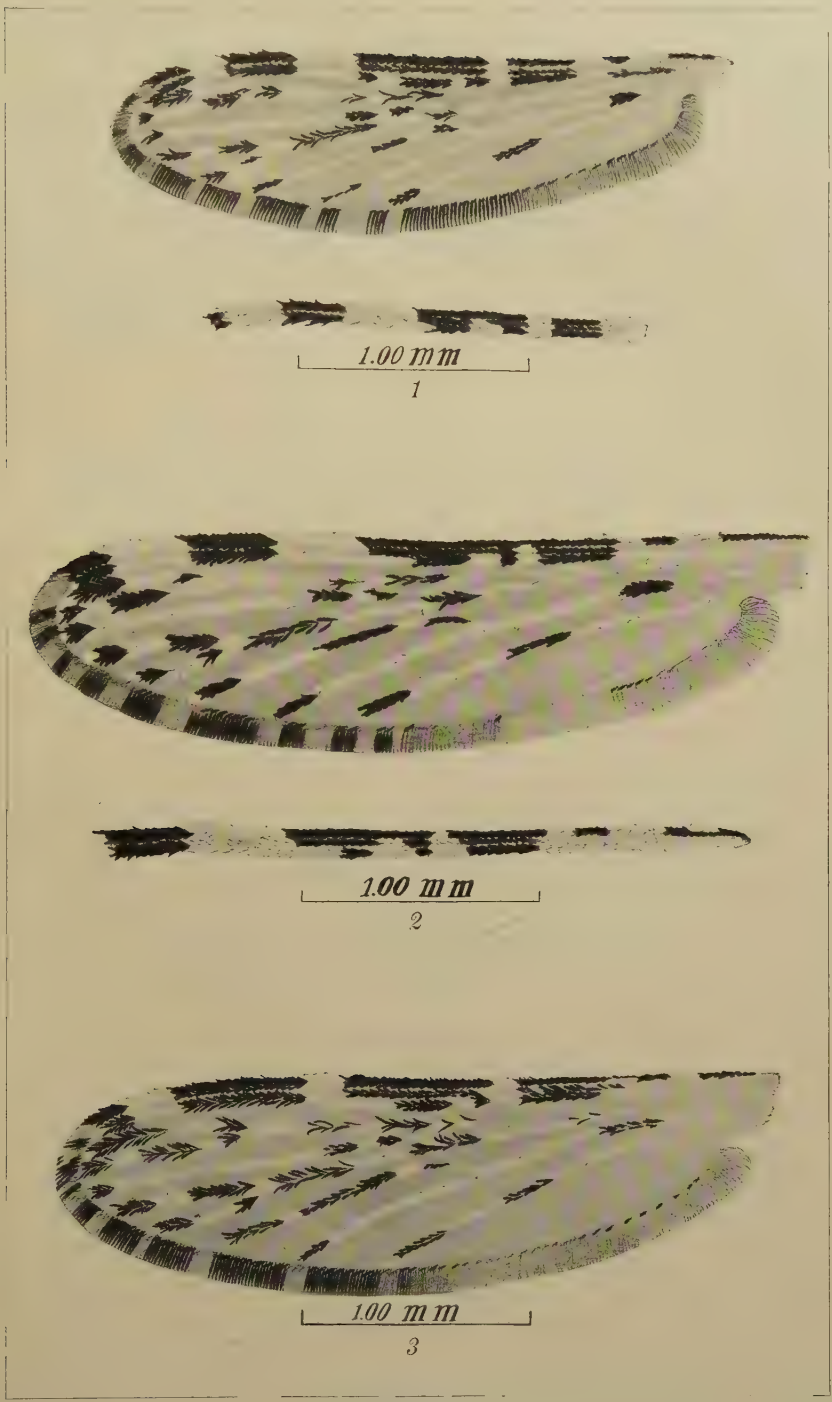
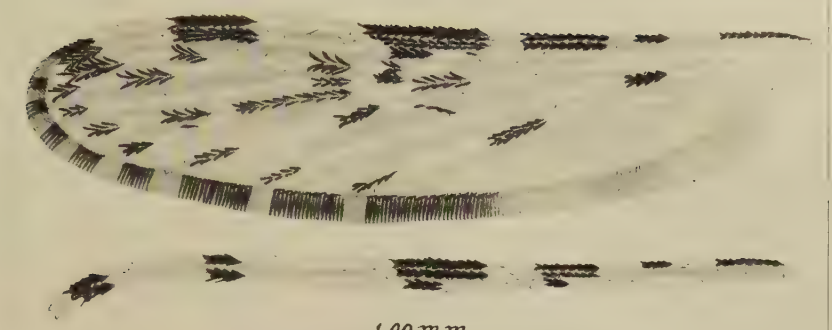


PLATE 1.



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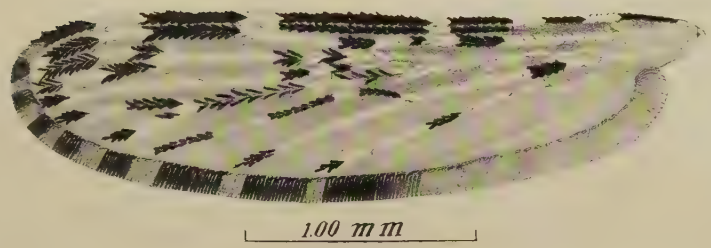

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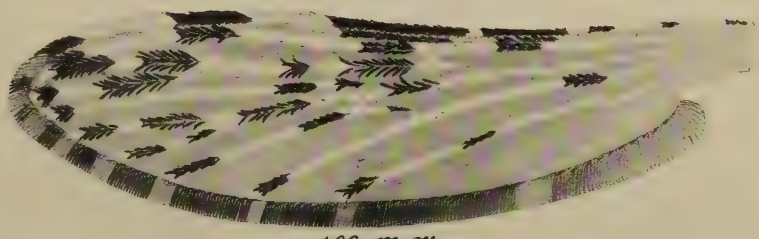

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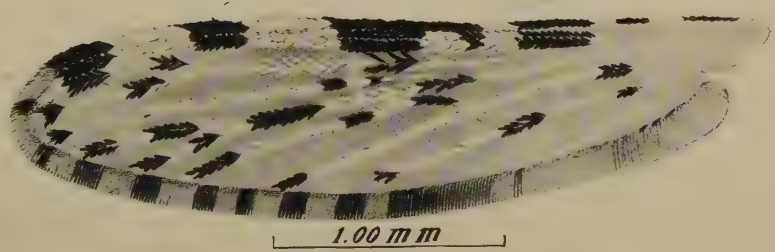

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PLATE 2.

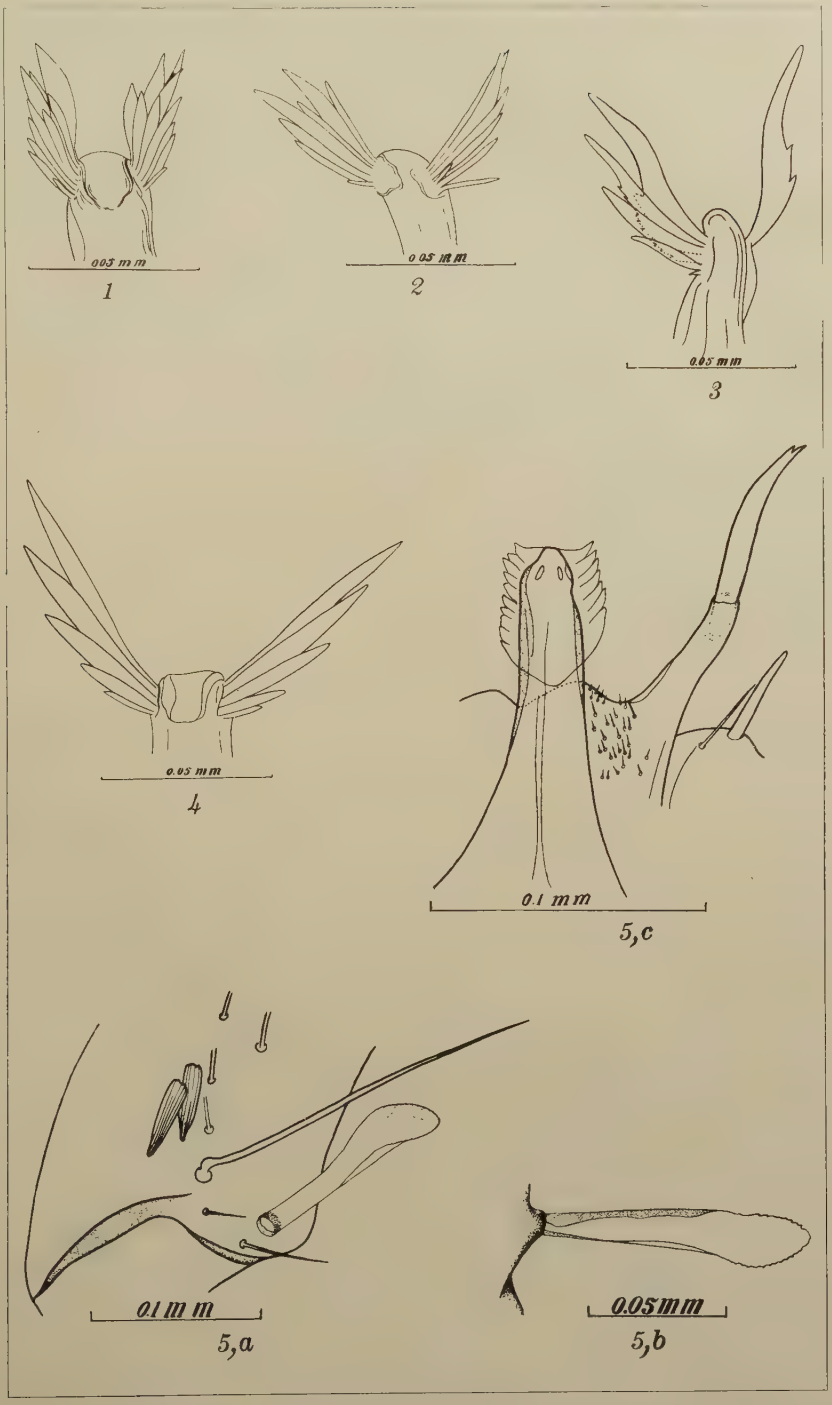

PLATE 3.

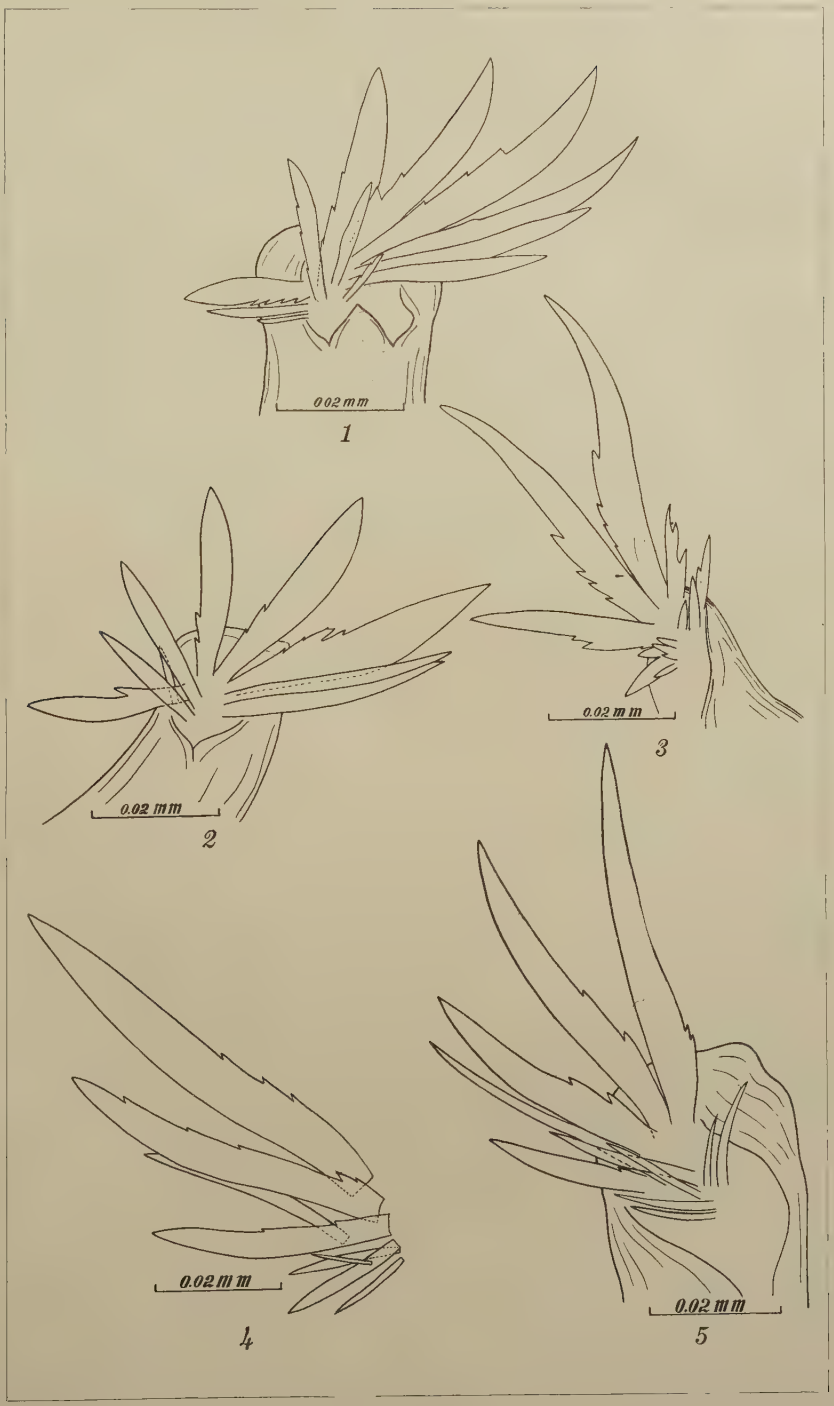

PLATE 4.

THE COMPOSITION OF PHILIPPINE WOODS, II

ANUBING, BALAKAT, MALAIKMO, BALAKAT-GUBAT BOLONGETA, AND SANTOL

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THREE PLATES

The virgin forests of the Philippines cover about 40,000 square miles and in addition there are about 20,000 square miles of second-growth forests.[1] Considerable portions of these forests are easily accessible for logging and as a result there are a number of sawmills now in operation.

The sawdust and other waste wood produced at these numerous sawmills are at present used merely as fuel. Some of this waste material may contain sufficient cellulose suitable for the manufacture of various commercial products.

Industries such as those that manufacture rayon and other products from cellulose use wood as their basic raw material. For such industries the composition of woods is a matter of considerable importance. It has been estimated that in the Philippines there are more than 2,500 species of trees. This is a much larger number than is found in all of the United States and Canada combined. As yet no systematic chemical analysis of tree species growing in the Philippines has been made. It therefore seemed desirable to analyze some of the commoner and better-known types of trees.

[1] Whitford, H. N., Bull. Philip. Bur. For. 10 (1911) 1.

Considerable data concerning the forests of the Philippines, species of trees, characteristics of the wood, and minor forest products have been published.[2]

EXPERIMENTAL PROCEDURE

The trees we have analyzed have the common names anubing, balakat, malaikmo, balakat-gubat, bolongeta, and santol. An account of the structure of these trees, local names, and general properties is given by Schneider.[3] According to Schneider[4] the durability of Philippine woods is divided into four classes which he describes in the following manner:

1. Very durable, for example, anubing, ipil, mancono, molave. Such woods are probably rarely attacked by insects, except after they have been softened by decay—that is, by attacks of fungi after long exposure to exceptionally severe conditions. They resist exposure to the weather or contact with the ground for long periods. All timbers in this class are believed to be at least equal to the most durable American woods and many of them surpass in durability any commercial timber of the temperate zone.

2. Durable, for example, calamansanay, palomaria, tindalo, tucang-calao. These woods are very rarely attacked by any insects and will last many years even in contact with the ground or exposed to the weather.

[2] Whitford, H. N., The Forests of the Philippines, Bull. P. I. Bur. Forestry 10 (1911).

Whitford, H. N., Philip. Journ. Sci. 1 (1906) 373; 637.

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[3] Bull. P. I. Bur. Forestry 14 (1916).

[4] Op. cit. 87.

3. Fairly durable, for example, apitong, guijo, kalumpit, catmon. Woods of this class are not commonly or severely attacked by insects. They resist the weather fairly well and last several years even in the ground. Most of the woods in this class would, it is believed, compare with the woods of average durability in the North Temperate Zone.

4. Not durable. These woods although not termite proof are not specially subject to attacks of other insects—that is to say, they are not invariably attacked as are certain other woods; but the sapwood is often poor in this respect and woods of this class unprotected by paint or preservatives should not be exposed to conditions of constant moisture or of constant alternation between moisture and dryness. Thus, they are not recommended for use in the ground or for exposure to the weather, when woods of the other classes are available. There is included in this class no wood believed to be inferior to the medium-grade construction timbers of the United States and the classification has been made with special reference to Oregon pine and California redwood, which are the woods most commonly imported into the Philippines. The various lauans, which form the great bulk of the timber of this class, are mechanically stronger than redwood and Oregon pine. Redwood is by no means immune to the attacks of termites, while Oregon pine is known to be destroyed by them in a comparatively short time.

Certain woods which are known to be less resistant than the lauans to decay and insects, have their degree of durability designated, not by numbers, but by such phrases as "durability poor," "often attacked by beetles," etc.

Brief descriptions of the Philippine woods analyzed in this investigation follow.

Anubing (*Artocarpus cumingiana* Trec.) sometimes grows to a diameter of 100 centimeters. The wood is hard and heavy and is difficult to work as it dulls tools very rapidly. Although it checks but little it is liable to warp if not carefully seasoned. It has a durability of 1 and is rarely attacked even by termites. It is used for piling, ships, bridges, poles, beams, mine timbers, ties, and paving blocks.

Balakat [*Ziziphus talanai* (Blco.)] is moderately hard and heavy. It is easy to work, has a durability of 4, and is often attacked by shot-hole borers. It is used for cheap construction, furniture, flooring, agricultural implements, and wooden-shoe soles.

Malaikmo [*Celtis philippinensis* (Blco.)] may attain a diameter of 100 centimeters. The wood is moderately hard, heavy, tough, and somewhat difficult to split. It seasons well, is fairly easy to work, has a durability of 3, and is not commonly attacked by insects. It may be used for beams, rafters, boxes, and temporary construction.

Balakat-gubat [*Sapium luzonicum* (Vid.) (Merr.)] is a tree which may reach a diameter of one meter and a height of 30

meters. It is a soft wood and is sometimes used in general construction work.

Bolongeta [*Diospyros pilosantera* (Blco.)] is very widely distributed and grows to a diameter of 50 centimeters. The wood is very similar to camagon. It is hard, heavy, and has a high specific gravity. It is difficult to season and to work but takes a beautiful finish under sharp tools. The heartwood has a durability of 1 and the sapwood 2. The wood is used for numerous purposes such as beams, rafters, musical instruments, cabinetwork and furniture.

Santol [*Sandoricum koetjape* (Merr.)] grows to a diameter of 70 centimeters or more, is widely distributed, and is one of the best known trees in the Philippines. The wood is soft and light. It seasons well, is easy to work, and has a durability of 3. Santol is used for carving sacred images. It is also employed for light framing, ceilings, household implements, and furniture.

The measurements of the trees used for our analysis are given in Table 1. They were all sound trees and representative specimens of their particular species. Although we analyzed wood samples from trees of different sizes yet they were all mature trees. In a recent investigation of Philippine bagtikan trees [5] it was found that the analysis of the individual mature trees, whether small or of medium size, was about the same for the principal constituents. If it is assumed that other species of trees give results like those obtained with bagtikan then the wood samples analyzed in this investigation are really representative of the individual species.

TABLE 1.—*Measurements of Philippine trees used for wood analysis.*

Measurement.	Anubing.	Balakat.	Malaikmo.	Balakat-gubat.	Bolongeta.	Santol.
Diameter.....cm..	29.0	43.0	26.0	45.0	24.0	32.0
Total height.....m..	16.5	18.2	18.19	22.59	22.0	19.75
Clear length of trunk.....m..	8.0	10.8	10			
Cut above ground.....m..	2.05	2.19	2.18	1.64	4.64	4.75

In analyzing the wood samples we used the standard methods adopted by the United States forest-products laboratory at Madison, Wisconsin.[6] For moisture, cold-water soluble, alkali

[5] Yenko, F. M., Luz Baens, Augustus P. West, and H. M. Curran, Philip. Journ. Sci. 47 (1932) 281.

[6] Bray, M. W., Paper Trade Journ. 87 (1928) No. 25, 59.
Schorger, A. W., Chemistry of Cellulose and Wood (1926) 505.

soluble, ether and alcohol extracts, ash, and nitrogen we followed, in general, the methods given by Schorger. In determining the cellulose, lignin, alpha cellulose, and hot-water soluble material we used the same procedures employed in a recent investigation of Philippine bagtikan woods.[7] These procedures were slight modifications of the standard methods.

RESULTS

The results of analyzing the woods recorded in this paper are given in Table 2.

TABLE 2.—*Analysis of Philippine woods.*

Constituent.	Anubing.	Balakat.	Malaikmo.	Balakatgubat.	Bolongeta.	Santol.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Moisture	9.27	8.65	8.91	8.26	8.95	8.30
Cold-water soluble	4.43	4.02	4.08	5.16	3.90	3.38
Hot-water soluble	7.02	5.90	6.95	6.81	7.02	6.07
Alkali soluble	20.42	11.24	13.01	15.97	15.01	18.08
Ether extract	0.68	0.77	0.46	0.24	0.46	2.49
Alcohol extract	6.04	4.28	3.15	7.63	4.23	3.91
Ash	2.26	1.70	1.81	1.62	1.53	0.55
Nitrogen	0.48	0.23	0.45	0.37	0.29	0.27
Cellulose	58.92	52.09	56.99	56.12	54.05	51.37
Ash in cellulose determined	0.80	0.58	0.55	0.65	0.44	0.41
Ash-free cellulose	58.12	51.51	56.44	55.47	53.61	50.96
Lignin	28.98	32.22	27.29	30.84	27.50	28.71
Alpha cellulose	76.38	76.45	75.22	78.37	82.23	77.81

As shown by the data (Table 2) the highest percentage of ash and cellulose was given by the wood from anubing. The percentage of nitrogen was approximately the same for all the woods. Balakat gave the highest percentage of lignin, while bolongeta gave the highest percentage of alpha cellulose.

Compared to some American woods[8] the Philippine woods seem to be more uniform in composition. The Philippine woods contain a somewhat higher percentage of lignin and a slightly lower percentage of cellulose than the American woods. All of these Philippine woods gave a high percentage of alpha cellulose which is an indication that they may be suitable for the manufacture of rayon.

[7] Yenko, F. M., Luz Baens, Augustus P. West, and H. M. Curran, Philip. Journ. Sci. 47 (1932) 281.

[8] Schorger, A. W., Journ. Ind. Eng. Chem. 9 (1917) 556.
Ritter, G. J., and L. C. Fleck, Journ. Ind. Eng. Chem. 14 (1922) 1050.
Mahood, S. A., and D. E. Cable, Journ. Ind. Eng. Chem. 14 (1922) 933.

SUMMARY

Six species of Philippine woods were analyzed in this investigation. They were woods commonly known as anubing, balakat, malaikmo, balakat-gubat, bolongeta, and santol.

The Philippine woods appear to be more uniform in composition than some American woods.

ILLUSTRATIONS

PLATE 1

Balakat. Large tree in the center.

PLATE 2

Santol. Large tree at left, with leaves on the trunk. Same tree as No. 436.

PLATE 3

FIG. 1. Balakat-gubat.
2. Anubing.
3. Bolongeta.
4. Malaikmo.

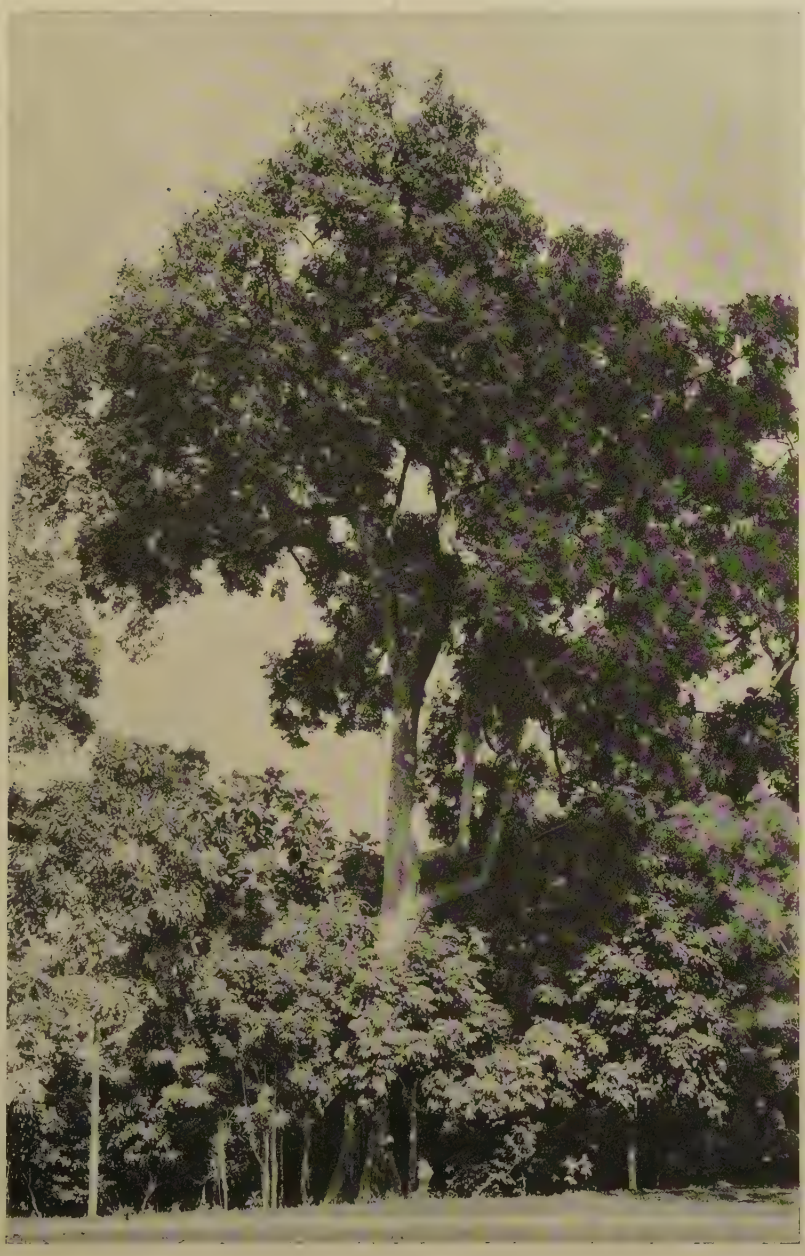

PLATE 1. BALAKAT.

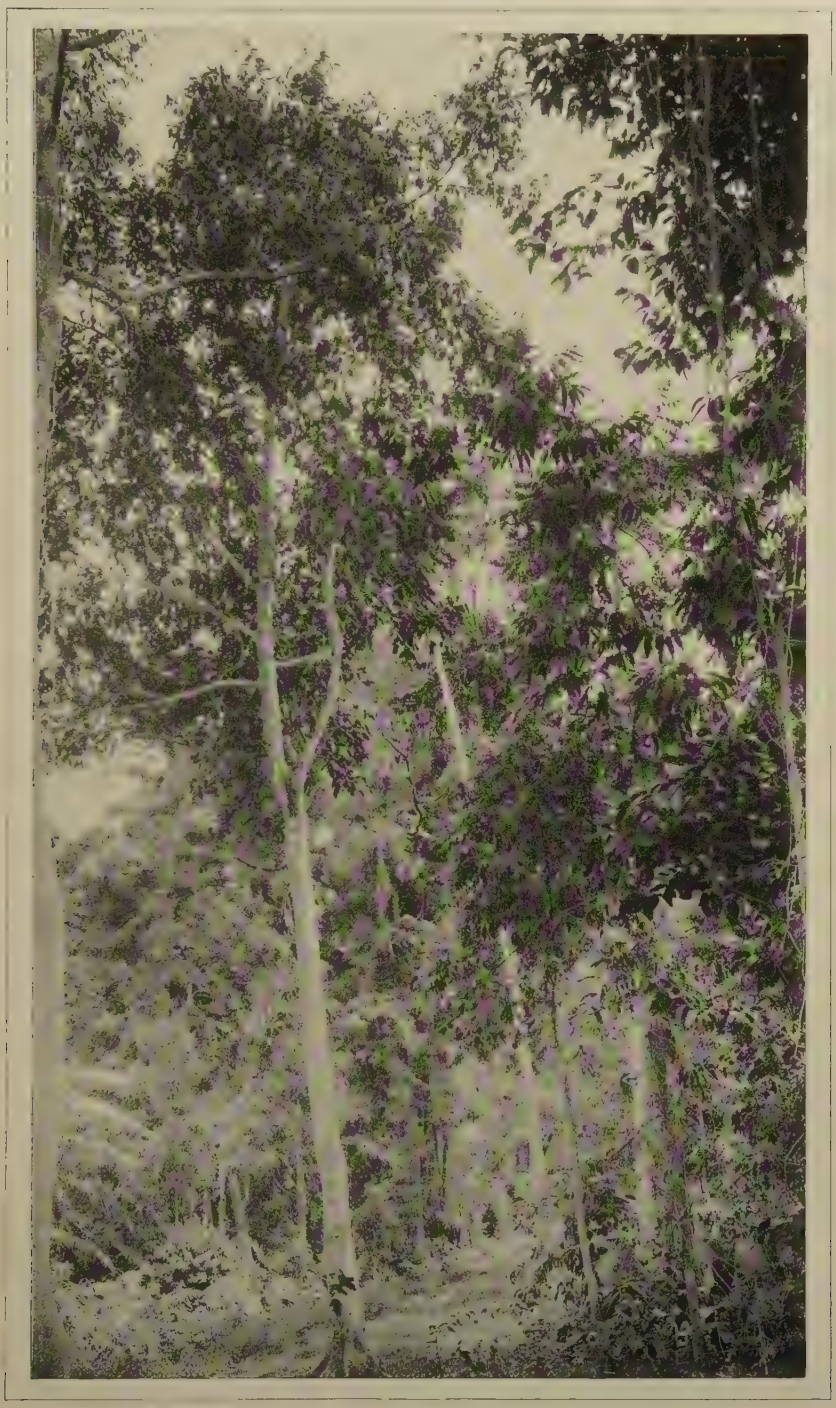

PLATE 2. SANTOL.

1

2

3

4

PLATE 3.

LEAD, BARIUM, AND MAGNESIUM SALTS OF HYDNOCARPIC AND CHAULMOOGRIC ACIDS[1]

By Howard Irving Cole

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Hydnocarpic and chaulmoogric acids in the form of their glyceryl esters are the main constituents of the hydnocarpus-group oils now widely used in the treatment of leprosy. These acids are optically active. They contain a double bond in the pentene ring and are therefore theoretically classed as unsaturated fatty acids. They react in some respects like unsaturated acids, absorbing iodine and bromine in theoretical amounts. On the other hand, being solid acids (melting point 60° and 68° C., respectively), they behave more like saturated fatty acids as regards their physical characteristics. In the ordinary methods of separation of saturated from unsaturated fatty acids based on differences in the solubility of their salts, these two acids appear associated with the former as well as with the latter group. In order, therefore, intelligently to work out a method for the separation of these acids based on the solubility of their metallic salts, some idea as to the relative solubility of these salts is a preliminary necessity. As no data are to be found on this subject in the literature, experiments were performed to determine the solubility of the lead, barium, and magnesium salts in certain solvents at various temperatures.

EXPERIMENTAL

The lead, barium, and magnesium salts of hydnocarpic and chaulmoogric acids were prepared from the pure acids according to the method of Whitemore and Lauro,[2] with some modifications, as follows:

Two grams of the fatty acid were dissolved in 25 cubic centimeters of 95 per cent alcohol and then exactly neutralized with

[1] Published with the approval of the Director of Health.

[2] Journ. Ind. Eng. Chem. 22 (1930) 647.

0.2 *N* sodium hydroxide with phenolphthalein as indicator. Most of the alcohol was evaporated off and the residue was diluted with water to make 150 cubic centimeters. If any cloudiness appeared, due to hydrolysis, sufficient alcohol was added to clarify the solution and inhibit the formation of acid soaps. A slight excess of lead or barium acetate or magnesium chloride was dissolved in 30 cubic centimeters of water and added slowly, with stirring, to the solution of the alkali soap, this procedure being preferable to adding the alkali soap solution to the solution of the metal salt. Precipitation of the metallic salt or soap occurred immediately. It was allowed to stand about an hour, filtered through paper and then washed with distilled water until the filtrate no longer gave a test for the metal ion. The metallic soaps were dried by spreading out on paper in an oven at 45° C. The lumps were then ground to a fine powder in a mortar, washed with ethyl ether to get rid of any free fatty acid that might be present, then dried to constant weight at 45° and again ground to a fine powder.

Solubility.—Solubility of these salts was determined in ethyl alcohol (95 per cent), ethyl ether, and benzol at 15° C., 30° C., and boiling, and in petroleum ether at 30° C. An excess of the finely powdered salt was vigorously shaken with the solvent for one hour in a constant-temperature bath and then filtered while in the bath as described below. Five cubic centimeters of the solution were evaporated in a weighed porcelain crucible, which was then heated in an oven at 45° C. to constant weight. The results were expressed in grams soluble in 100 cubic centimeters solvent.

Separation of the solution from the undissolved salt was accomplished as follows: The flask is corked with a stopper through which two glass tubes are passed; one, bent at right angles, reaching only to the bottom of the stopper is connected to a rubber bulb with valve, the other of 1 to 1.5 millimeters inside diameter, bent in an inverted U, reaches to the bottom of the flask; the inside end of this tube is plugged lightly with cotton which acts as a filter. Pressure applied by squeezing the bulb forces the filtered liquid out while the temperature of filtration remains constant, the flask being immersed in the constant-temperature bath during the filtration.

TABLE 1.—*Melting points of metallic salts of hydnocarpic and chaulmoogric acids.*

Salt.	Melting point ° C.
Lead hydnocarpate	77–78
Lead chaulmoograte	83
Barium hydnocarpate	120
Barium chaulmoograte	123
Magnesium hydnocarpate	Begins to soften at 80°.
Magnesium chaulmoograte	Begins to soften at 100°.

A generous excess of undissolved salt and vigorous shaking reduces the possibility of supersaturation. One hour was found to be sufficient time for the solvent to reach practical saturation provided the salt was in a finely powdered condition. As this work was undertaken in order to find the relative solubilities of these salts as compared with the similar common fatty acid salts, no attempt was made to obtain ultimate solubilities. The solubilities found will, however, be those encountered in ordinary laboratory analyses of these salts.

The melting points of the salts were determined and are given in Table 1.

The lead and barium hydnocarpates and chaulmoograte are white, amorphous powders, slightly tacky when ground. The magnesium salts of these acids are voluminous white amorphous powders with no tackiness. The solubilities of all of these salts in the solvents mentioned above, as well as those of lauric, palmitic, stearic, and oleic acids, where available, are given in Tables 2, 3, and 4. The low value obtained for solubility of magnesium hydnocarpate in boiling alcohol is probably due to the fact that the salt begins to soften and agglomerate in the alcohol at about 60° C., thereby offering less surface to the solvent.

CONCLUSIONS

The solubilities of the lead, barium, and magnesium salts of hydnocarpic and chaulmoogric acids in ethyl alcohol, ether, benzol, and petroleum ether have been determined. These solubilities lie in general between those of the corresponding salts of the common saturated (solid) and those of the ordinary unsaturated (liquid) fatty acids.

266031——4

An examination of Table 2 shows that the lead salts of these acids may be expected to appear in both the "solid" and "liquid" fractions when any attempt is made to isolate them by the lead-salt-ether method. This expectation is borne out in practice.

Advantage might be taken of the relatively high solubility of the lead salts of hydnocarpic and chaulmoogric acids in hot alcohol to separate them from the lead salts of the saturated fatty acids. Oleic and other liquid fatty acids might be eliminated by extracting with petroleum ether in which the above-mentioned salts are only very sparingly soluble. Experiments leading to such a method of separation are now in progress.

Complete separation of hydnocarpic from chaulmoogric acid by fractional crystallization of their lead, barium, or magnesium salts from the solvents tested would not appear to be possible, owing to the fact that their solubility factors lie too close together.

TABLE 2.—*Solubility of lead salts of fatty acids, in grams per 100 cubic centimeters.*

Lead.	Ethyl alcohol (95 per cent).			Ethyl ether.		
	15° C.	30° C.	Boiling.	15° C.	30° C.	Boiling.
Hydnocarpate	0.11	0.20	1.13	0.16	0.32	0.98
Chaulmoograte	0.08	0.19	0.91	0.05	0.10	0.29
Laurate	[a] 0.0047	----	[a] 0.235	[b] 0.010	----	[c] 0.020
Palmitate	[d]	----	[c] 0.012	[b] 0.010	----	[c] 0.026
Stearate	[d]	----	[c] 0.004	[b] 0.007	----	[f]
Oleate	[g]	----	----	[h]	----	[h]

Lead.	Benzol.			Petroleum ether (30°–60°) 30° C.
	15° C.	30° C.	Boiling.	
Hydnocarpate	0.09	0.15	2.92	0.014
Chaulmoograte	0.05	0.06	2.42	0.008
Laurate	[b] 0.011	----	----	[d]
Palmitate	[b] 0.009	----	----	[d]
Stearate	[b] 0.008	----	----	[d]
Oleate	----	----	----	[h]

[a] Lewkowitsch, 6th ed. 1: 159.
[b] Seidell.
[c] Lewkowitsch, op. cit. 144.
[d] Insoluble, Seidell.
[e] Seidell (at 50° C.).
[f] Insoluble, Lewkowitsch, op. cit. 144.
[g] Slightly soluble, op. cit. 192.
[h] Easily soluble, ibid.

TABLE 3.—*Solubility of barium salts of fatty acids, in grams per 100 cubic centimeters.*

Barium.	Ethyl alcohol (95 per cent).			Ethyl ether.		
	15° C.	30° C.	Boiling.	15° C.	30° C.	Boiling.
Hydnocarpate	0.07	0.08	0.39	0.03	0.04	0.06
Chaulmoograte	0.03	0.05	0.34	0.02	0.02	0.04
Laurate	0.019		[a] 0.10			
Palmitate	[b] 0.0035		[b] 0.013			
Stearate	(c)		(c)			
Oleate			(i)			

Barium.	Benzol.			Petroleum ether (30°–60°) 30° C.
	15° C.	30° C.	Boiling.	
Hydnocarpate	0.025	0.04	0.18	0.022
Chaulmoograte	0.02	0.03	0.07	0.016
Laurate				
Palmitate				
Stearate				
Oleate				

[a] Lewkowitsch, 6th ed. 1: 159.
[b] Op. cit. 163.
[c] Insoluble, op. cit. 169.
[d] Sparingly soluble, op. cit. 191.

TABLE 4.—*Solubility of magnesium salts of fatty acids, in grams per 100 cubic centimeters.*

Magnesium.	Ethyl alcohol (95 per cent).			Ethyl ether.		
	15° C.	30° C.	Boiling.	15° C.	30° C.	Boiling.
Hydnocarpate	0.51	0.67	0.56	0.04	0.045	0.036
Chaulmoograte	0.37	0.44	0.46	0.02	0.036	0.024
Laurate	[a] 1.52		[a] 12.67		[b] 0.015	
Palmitate	[c] 0.034		[c] 0.151		[b] 0.004	
Stearate	[c] 0.017	[d] 0.006			[b] 0.003	
Oleate	[c] 0.17					

Magnesium.	Benzol.			Petroleum ether (30°–60°) 30° C.
	15° C.	30° C.	Boiling.	
Hydnocarpate	0.02	0.04	21.42	0.0008
Chaulmoograte	0.01	0.004	20.07	0.0005
Laurate				
Palmitate				
Stearate				
Oleate				

[a] Lewkowitsch, 6th ed. 1: 159.
[b] Jacobson and Holmes, Journ. Biol. Chem. 25 (1916) 29 (at 25° C.).
[c] Ibid. (absolute alcohol used).
[d] Thomas and Yu, Journ. Am. Chem. Soc. 45 (1923) 117 (at 25° C.).

REMARK ABOUT ANONAINE

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The formula $C_{17}H_{16}NO_3$, which the writer assigned to anonaine,[1] should be changed to $C_{17}H_{17}NO_3$, because of the uneven sum of the valences in the former. The analytical results then reported; namely, C 72.2, 72.5, 72.8, average, 72.5; H. 5.6, 6.1, 5.7, average, 5.8; N 4.9, 4.8, average, 4.85, agree also very well with $C_{17}H_{17}NO_3$, which requires C 72.1, H 6.0, N 4.9.

Manila, September 15, 1931.

[1] Philip. Journ. Sci. 43 (1930) 561–564; 44 (1931) 409–410.

THE POISONOUS CONSTITUENT OF CORIARIA INTERMEDIA MATSUMURA

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THREE PLATES

Coriaria intermedia Matsumura is a shrub from 1 to 3 meters high. Its distribution in the Philippines is limited to the Mountain Province, northern Luzon, where it is known to the Igorots under the vernacular names *buakat, baket,* and *bikit.*(6) The chemical study of this plant is of particular interest owing to the fact that many of the allied species from Europe, New Zealand, Mexico, and Japan have been reported to contain poisonous substances of the picrotoxin group. Thus, coriamyrtin, which is a violent convulsive poison was first isolated by Riban(7) from *Coriaria myrtifolia* Linn. It was also obtained by Yoshitake(5) from *C. japonica* A. Gray. The toxic constituent (tutin) of the tutu poison of New Zealand resembles coriamyrtin in its pharmacological action and was found by Easterfield and Aston(3) in *C. thymifolia* Humb. and Bonpl.[1] They also noted it in *C. ruscifolia* Linn.[2] and in *C. angustissima* Hook. f.

According to Watt(10) several Indian authors state that the leaves of *C. nepalensis* Wall. act as a powerful poison when given in large doses and the seeds sometimes produce symptoms like tetanus.

Concerning *C. intermedia* Matsum. (the only *Coriaria* species known in the Philippines), Santos(9) states that some inhabitants of Trinidad Valley, Mountain Province, informed him of a case of poisoning by this plant. They said that one couple and their two children died after taking a decoction of the fruits and leaves of *C. intermedia,* which they mistook for their native Benguet tea. The poisonous property of *C. intermedia* was

[1] *Coriaria atropurpurea* Moç and Sesse. Index Kewensis 1 (1895) 618.

[2] *Coriaria sarmentosa* Forst. f., *C. arborea* Lindsay, and *C. tutu* Lindsay. Cheeseman, Manual of the New Zealand Flora (1906) 105.

further shown by Wells,(11) who reports the toxic effect produced in a guinea pig after an intraperitoneal injection of 2 cubic centimeters of the plant extract, representing 20 grams of the fresh plant.

As to the chemical nature of the poisonous constituent of *C. intermedia* Matsum., there is so far no investigation that has definitely established the chemical identity and the properties of the active principle of this plant. Wells(11) states that he obtained 69 grams of the crude, poisonous glucoside from 100 kilograms of the fresh plant, but made no further attempt to identify this particular glucoside, nor did he prove that the poisonous property of the plant was directly due to it. It seemed, therefore, advisable to undertake a further study of this plant.

The results of this investigation indicate that the Philippine *Coriaria* contains coriamyrtin, and pharmacological tests have shown that this substance is the poisonous constituent of the plant. Coriamyrtin was found to be present in small quantities in the leaves, stems, and fruits, but more in the fruits than in the other parts. The leaves contain a considerable amount of pyrogallol tannin, and in this respect the plant may be useful as a tanning material like the currier's sumac or redoul of France (*C. myrtifolia* Linn.). Elementary analysis and molecular-weight determination show coriamyrtin from *C. intermedia* Matsum. to have the molecular formula $C_{15}H_{18}O_5$. This is half the formula formerly assigned to this compound by Riban,(7) a difference already pointed out by Easterfield and Aston(3) and recently confirmed by Kariyone and Sato(5) who reinvestigated *C. japonica* A. Gray. Coriamyrtin crystallizes in colorless prisms which appear to be of the monoclinic system (Plates 1, 2, and 3). It dissolves in ether and alcohol but is sparingly soluble in water. It melts at 218° C., is dextrorotatory, and reduces Fehling's solution after it is hydrolyzed with acid. Treated with hydriodic acid and subsequently with an alcoholic solution of potash a purple-red color is obtained. No characteristic osazones are formed when treated, before and after acid hydrolysis, with an excess of phenylhydrazine. It is not hydrolyzed by emulsin, a test which is generally used for the detection of a naturally occurring glucoside. From the data above it would seem that coriamyrtin is apparently not a glucoside.

EXPERIMENTAL

The plant was collected in the neighborhood of Baguio, Mountain Province, Luzon. The leaves, stems, and fruits were air-dried and powdered. The stems and fruits were utilized mainly for the quantitative estimation of the active constituent. The leaves, representing the bulk of the material, were used for the isolation of coriamyrtin required for further experimental data.

Extraction of coriamyrtin.—The method employed for the separation of this compound is essentially that recommended by Riban(8) for *C. myrtifolia* Linn. Since certain modifications were adopted in removing the excess lead in the filtrate and the purification of coriamyrtin, it would seem desirable to describe the method that was followed. Several kilograms of powdered leaves were boiled with water in successive portions and the combined supernatant liquid was filtered. The highly colored filtrate contained a considerable amount of tannin, as shown by the copious blue-black precipitate which was obtained when a portion was tested with ferric salts. For the removal of tannin and other interfering substances, the filtrate was treated successively with a concentrated solution of neutral lead acetate and basic lead acetate. The precipitate was removed by filtering and washed well with water. The washings were added to the filtrate. The yellow precipitate was suspended in water and the lead compound decomposed by hydrogen sulphide. The aqueous solution obtained, after removal of the lead sulphide, was concentrated on a water bath, allowed to cool, and then extracted several times with ether. The resulting greenish yellow ether solution was distilled and the crystalline residue redissolved in a small amount of ether. The solution upon evaporation gave yellow crystals, which were purified by first dissolving them in methyl alcohol and then decolorizing the solution with purified animal charcoal. The pure substance thus obtained crystallized in colorless, silky needles. The crystals melted at 220° C., reduced Fehling's solution readily, and responded to the usual color reactions of gallic acid. The determination of the molecular weight from the neutralization value gave the following results:

	Neutralization value.	Molecular weight.
Calculated for gallic acid ($C_7H_6O_5$)	329.4	170
Found	322.8	173.8
Do	323.9	173.2

The filtrate and washings from the lead precipitate were treated with potassium oxalate to eliminate the excess lead salts, and then decolorized with Merck's extra pure animal charcoal. The clear aqueous solution thus obtained, when tested with ferric chloride solution, gave a negative result for the presence of tannin. This solution was then evaporated to a small volume on a water bath, cooled to room temperature, and the concentrated solution extracted several times with ether. The combined ether extracts were treated with anhydrous sodium sulphate and filtered. The filtrate was distilled, and the residual crystalline mass was redissolved in a small amount of ether. Upon evaporation, yellowish white crystals were obtained. These were recrystallized twice from ether and further purified by dissolving them in methyl alcohol and treating the solution with a very small amount of Merck's charcoal. The purified substance was obtained as colorless crystals melting at 218° C. From ether and ethyl alcohol the crystals separate in short needles or clusters of radiating prisms; from methyl alcohol, in aggregates of fine monoclinic prisms in dentritic form; and from water, in acicular or prismatic monoclinic crystals. They are soluble in ether and alcohol but dissolve sparingly in water. They do not respond to the alkaloidal tests and contain no nitrogen. They were identified as coriamyrtin from an elementary microanalysis [3] and a molecular-weight determination by the Rast method.(4)

	Carbon.	Hydrogen.	Molecular weight.
	Per cent.	*Per cent.*	
Calculated for $C_{15}H_{18}O_5$	64.76	6.47	280
Found	63.95	6.47	278.3
Do	63.53	6.72	277.3

A determination of the specific rotation in alcoholic solution using a 50-millimeter tube gave $\left(A\frac{30° C.}{D}\right) + 42.68°$.

Qualitative tests for coriamyrtin gave the following results: An aqueous solution did not produce a blue black or greenish coloration with ferric chloride. A greenish brown color was observed when a few crystals were moistened with concentrated

[3] The writer is indebted to Dr. Alfredo Santos, of the School of Pharmacy, University of the Philippines, for the elementary analysis of the substance.

sulphuric acid. Potassium permanganate solution was decolorized, and when treated with alcoholic potassium hydroxide no color was developed.

Riban's sensitive test(8) for coriamyrtin gave a positive reaction. This test consists in moistening a few crystals of the substance with concentrated hydriodic acid and evaporating on a water bath. When the residue is dissolved in alcoholic potassium hydroxide an intense purple-red color is developed. This color is destroyed by the addition of water.

In order to determine if the substance is a glucoside, the following experiments were performed:

1. (*a*) An aqueous solution containing 0.0144 gram of the substance was boiled with Fehling's solution and the amount of the cuprous oxide was determined according to the procedure of Munson and Walker(12) for the determination of reducing sugars.

1. (*b*) Another aliquot portion of the solution, equivalent to 0.0144 gram of the substance, was hydrolyzed with dilute sulphuric acid and then neutralized with sodium carbonate. The reduction with Fehling's solution was estimated in the same manner as in (*a*).

1. (*c*) A blank determination, consisting of the Fehling's solution alone, was also made.

	Cuprous oxide. Gram.
Before acid hydrolysis	0.0031
After acid hydrolysis	0.0076
Blank determination	0.0031

2. To individual flasks, each containing 0.015 gram of the coriamyrtin in aqueous solution, were added 10 cubic centimeters of emulsin solution (0.5 per cent), and the mixtures were incubated overnight at 37° C. The reducing sugars were then determined according to the method used in test 1 above. A blank determination was also made by simply heating the solution of coriamyrtin and emulsin on a boiling-water bath for one hour and then determining the reducing sugars in the usual manner. In each case no increase in the reduction of Fehling's solution was noted. (Cuprous oxide obtained was 0.0073 gram.) The activity of the Kahlbaum emulsin was first tested with amygdalin and found to be active.

3. A few milligrams of the coriamyrtin were dissolved in dilute hydrochloric acid. The solution was boiled for a few min-

utes, neutralized with sodium carbonate, and tested for osazones. An amorphous precipitate, soluble in ether, was obtained, indicating the absence of osazones.

From these experiments it would appear that coriamyrtin is not a glucoside, for it failed to produce the characteristic osazone and was not hydrolyzed by emulsin. As shown by Bourquelot,(1) emulsin hydrolyzes the beta glucosides. All naturally occurring glucosides, so far as is known, occur only in the beta form. The slight reduction of Fehling's solution when it was boiled with coriamyrtin (previously hydrolyzed with acid) does not necessarily mean that coriamyrtin is a glucoside. Any aliphatic substance containing a potentially active aldehyde or ketone group has a reducing property. Kariyone and Sato,(5) who obtained coriamyrtin (from *C. japonica* A. Gray), are also of the opinion that this substance is not a glucoside. Possibly coriamyrtin may be assigned to the undefined group called "Corps neutres."

For the quantitative estimation of coriamyrtin in leaves, stems, and fruits, the method described above for the extraction of coriamyrtin from the leaves was followed. The results, calculated on a moisture-free basis, showed that the fruits contained 0.176 per cent of the active constituent, the leaves 0.069 per cent, and the stems, 0.041 per cent.

A tannin determination in the leaves according to Lowenthal-Proctor's method(2) gave 29.00 per cent tannin computed on a moisture-free basis. The tannin belongs to the pyrogallol group as shown by the dark blue color with ferric chloride and by the absence of a precipitate with bromine water.

The poisonous property of the plant and of the isolated coriamyrtin was tested as follows:[4]

1. Two cubic centimeters of the concentrated plant extract, representing 1 gram of the dried powdered leaves, were injected subcutaneously into a guinea pig weighing 420 grams. The animal suffered clonic convulsions five minutes after the injection and died twenty minutes after.

2. Three guinea pigs, weighing 174, 184, and 190 grams, respectively, were each injected subcutaneously with 0.5 cubic centimeter of the aqueous solution of coriamyrtin (equivalent to 0.7 milligram of coriamyrtin). One minute after the injection there was a violent emprosthonic convulsion, which was fol-

[4] The writer desires to thank Dr. Onofre Garcia, of the Bureau of Science, for assistance with these experiments.

lowed by clonic movements. The three animals died six minutes later.

3. A dose of 0.14 milligram of coriamyrtin in aqueous solution given by subcutaneous injection to a guinea pig weighing 170 grams produced the same symptoms as described, but the animal recovered from the effect of the drug two hours after.

SUMMARY

Coriaria intermedia Matsumura is a shrub that occurs in the Mountain Province of the Philippines.

A chemical study of this plant indicates that it contains the poisonous constituent coriamyrtin.

Computed on a moisture-free basis, the amounts of coriamyrtin found in the fruits, leaves, and stems were 0.176, 0.069, and 0.041 per cent, respectively.

Coriamyrtin crystallizes in monoclinic prisms. These crystals are soluble in ether and alcohol but are sparingly soluble in water.

Coriamyrtin melts at 218° C., has an optical rotation of + 42.68°, and appears to have the molecular formula $C_{15}H_{18}O_5$.

Coriamyrtin (after acid hydrolysis) reduces Fehling's solution slightly; but apparently it is not a glucoside, for it does not produce a characteristic osazone and is not hydrolyzed by emulsin.

The toxic effect of coriamyrtin was shown by injecting guinea pigs subcutaneously with an aqueous solution containing varying amounts of the substance. Clonic convulsions were the usual symptom observed.

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ILLUSTRATIONS

PLATE 1

FIG. 1. Clusters of radiating, prismatic crystals of coriamyrtin crystallized from concentrated ethereal solution.

2. Needlelike crystals of the same substance from diluted ethereal solution.

PLATE 2

FIG. 3. Prismatic crystals of coriamyrtin which separated from ethyl alcohol.

4. The same substance occurring as aggregates of fine monoclinic prisms in dentritic form when crystallized from methyl alcohol.

PLATE 3

FIG. 5. Monoclinic prismatic crystals of coriamyrtin from diluted aqueous solution.

6. Acicular monoclinic crystals of the same substance from concentrated aqueous solution.

1

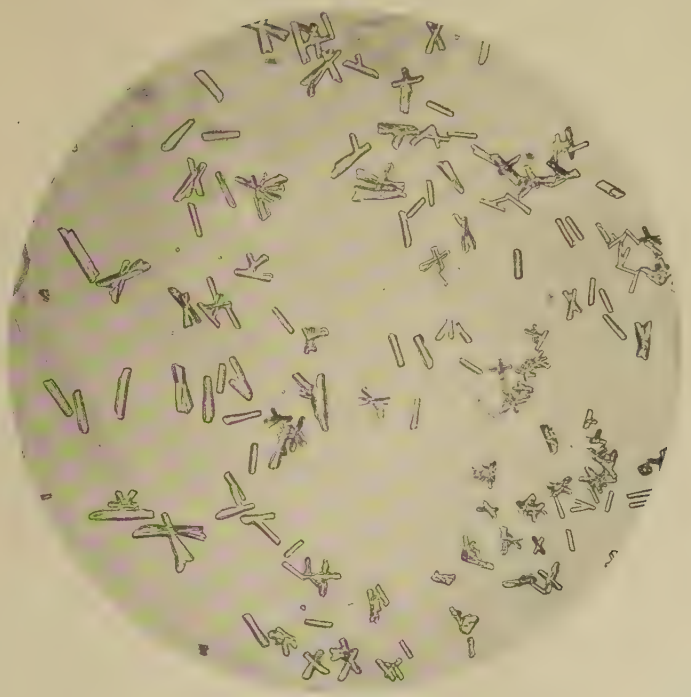

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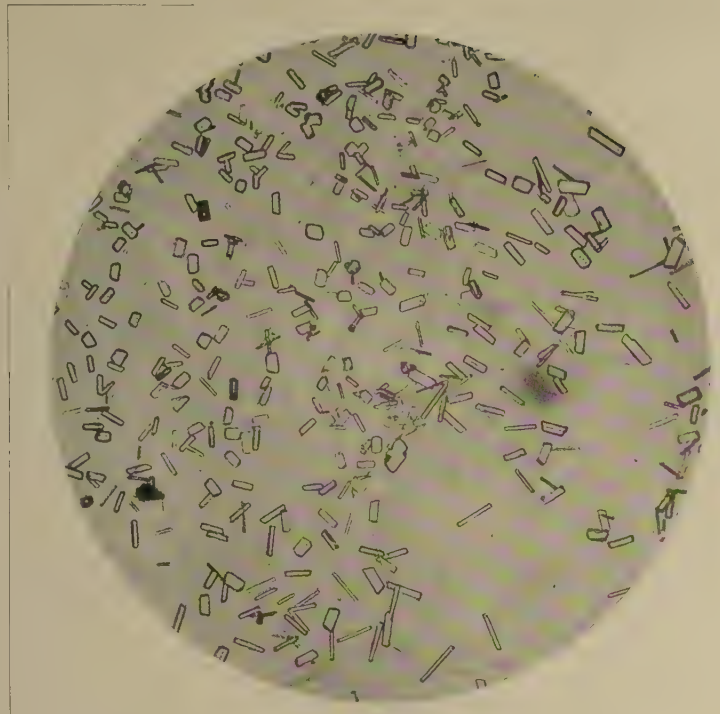
PLATE 1.



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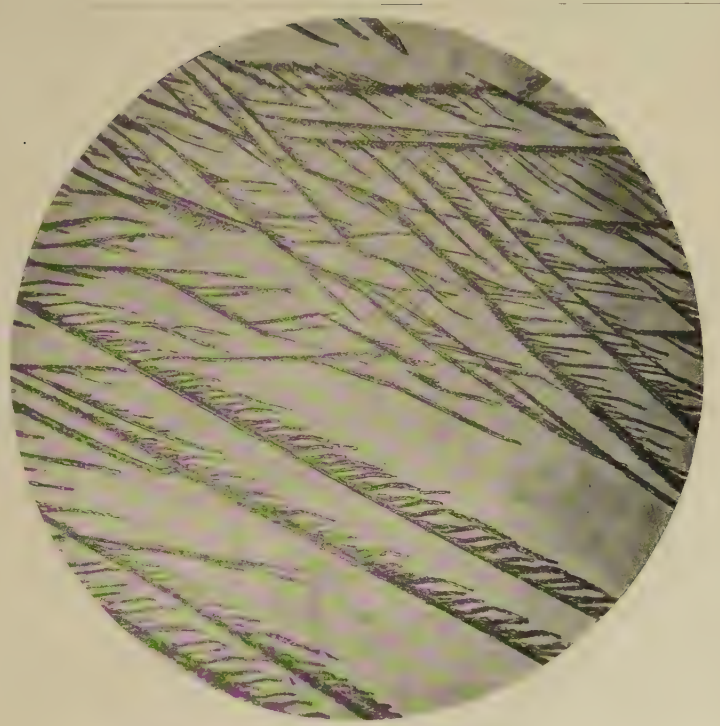

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PLATE 2.

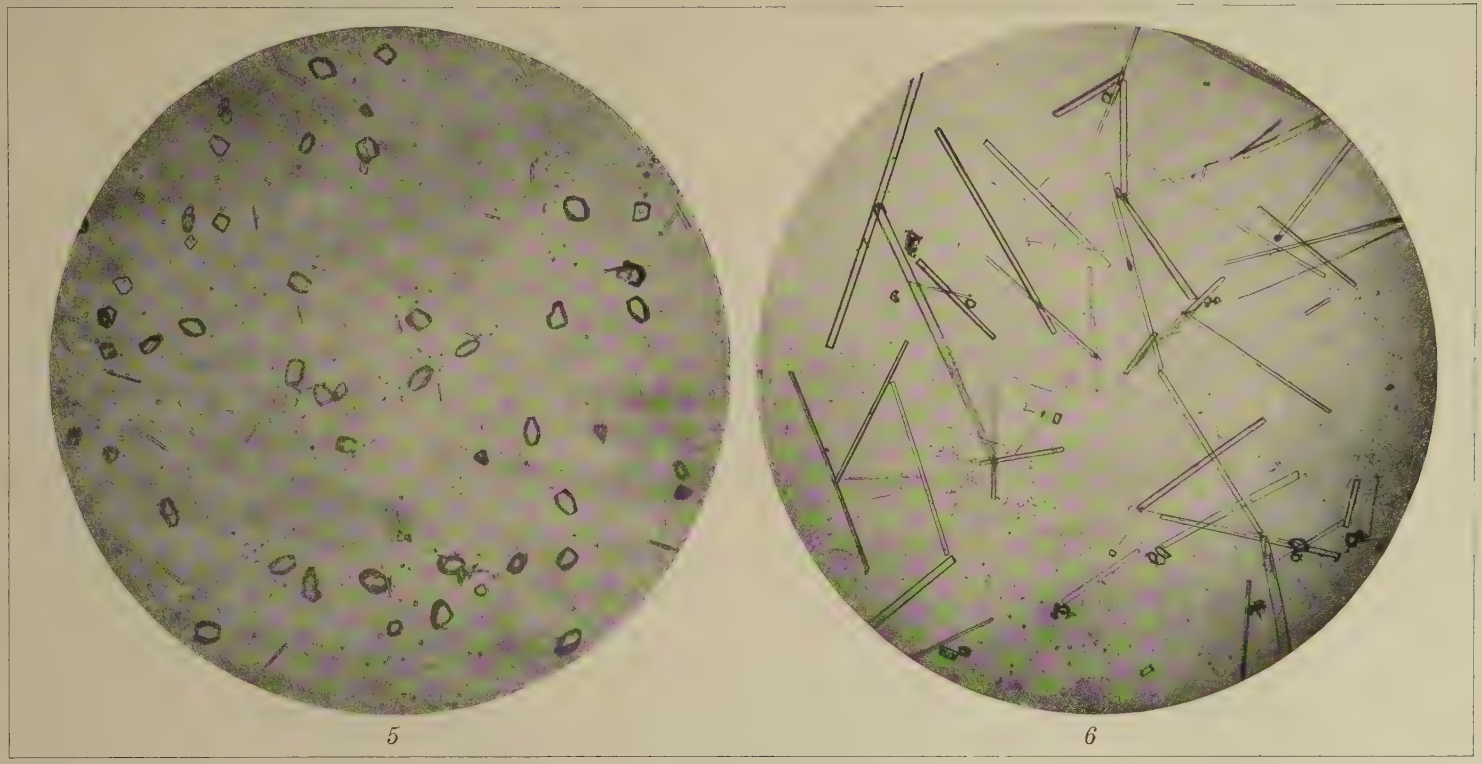

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PLATE 3.

TREMATODE PARASITES OF PHILIPPINE VERTEBRATES, V

FLUKES FROM BIRDS

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ELEVEN PLATES AND FIVE TEXT FIGURES

Some of the flukes described below were collected several years ago in the neighborhood of Laguna de Bay while the writer was still with the University of the Philippines at Los Baños, Laguna. The others were obtained from birds skinned for mounting purposes and made available for dissection through the courtesy of Mr. R. C. McGregor and his assistants in the section of ornithology, Bureau of Science. The writer is much indebted to these gentlemen and wishes here to express his thanks.

In this paper are reported for the first time from the Philippines representatives of the interesting groups of trematodes commonly known as monostomes (families Cyclocoelidæ and Notocotylidæ) and holostomes (family Strigeidæ). The fact that domestic ducks in the Philippines are infested with several species of flukes, some of which are identical with those of domestic ducks and other birds in Europe and elsewhere, is also worth while noting.

MONOSTOMES

CYCLOCOELIUM (POSTPHARYNGEUM) ORIENTALE var. EURHINUS var. nov. Plate 1, fig. 1.

Numerous specimens of this fluke were collected from the cervical air sac of *Totanus eurhinus* caught in Obando, Bulacan. It is referred to the subgenus *Postpharyngeum* Witenberg, 1926, of the genus *Cyclocoelium* Brandes, 1892, because of the shape of its body, the subterminal position of the mouth opening, the small size of the pharynx, and the moderate development of the vitelline glands. Compared with the already known members of the subgenus, it appears to be most closely related to *C. leidyi* Harrah, 1922, and to *C. orientale* Skrjabin, 1913. It may be distinguished from the former by its longer œsophagus and by

its larger eggs and testes, which are more widely separated from each other. It differs from the latter, a parasite of two species of *Totanus* in Russian Turkestan, only in the size of the eggs and in the contour of the inner walls of the intestinal cæca, which characters are considered not sufficient to separate the two forms into two distinct species.

Description.—Body large, attenuated anteriorly, rounded posteriorly, 14.20 to 21.20 millimeters in length by 2.90 to 4.30 millimeters in maximum breadth behind middle of body length. Cuticle unarmed. Mouth opening subterminal, leads through funnel-shaped passage to globular pharynx 0.26 to 0.29 millimeter in transverse diameter; œsophagus S-shaped, 0.30 to 0.70 millimeter long; intestinal cæca wide in diameter, slightly wavy in outline, with smooth inner walls, and often filled with yellowish food material; they run parallel and close to lateral margins of body, uniting at the posterior end to form an arch.

Testes globular or very slightly compressed, intercæcal, one behind the other, being separated by a distance of 1.40 to 2.85 millimeters; they are normally located to one side of the median line, but sometimes the second testis is almost median in position, being immediately in front of intestinal arch; they are unequal in size, the anterior testis measuring 0.56 to 0.92 millimeter and the posterior testis 0.80 to 1.10 millimeters in transverse diameter. Cirrus sac elongate, thin walled, 0.70 to 0.80 by 0.15 to 0.20 millimeter in size, to one side of median line, usually lateral to œsophagus and corresponding intestinal cæcum; incloses small vesicula seminalis, protrusible cirrus, and poorly developed pars prostatica. Common genital pore median, ventral to pharynx.

Ovary globular, 0.38 to 0.44 millimeter in diameter, intertesticular, to one side of median line opposite testes, forming with latter a sort of triangle. Shell gland compact, almost as large as and behind ovary. Oviduct arises from posterior border of ovary; neither receptaculum seminis nor Laurer's canal apparent, the proximal portion of the uterus being usually swollen and probably serving as seminal receptacle. Uterus with numerous transverse loops, filling up most of space between intestinal cæca anterior to second testis; the coils do not usually extend laterally across inner walls of cæca. Vitellaria in distinct, moderately large follicles, extracæcal, extending from œsophageal bifurcation or slightly behind that level to posterior end of body where the follicles of both sides are separated only

by excretory bladder; transverse vitelline ducts immediately in front of second testis. Eggs (in mounted specimens) oval, operculated, yellowish, 116.5 to 139.3 by 77.0 to 79.0 microns in size; those in distal portion of uterus inclose miracidia with conspicuous eyespots.

Excretory pore median, on dorsal surface near posterior end of body; excretory bladder flattened or somewhat triangular, between intestinal arch and posterior end of body; main lateral excretory vessels given off from each side of bladder, but their anterior course is difficult to trace in preserved specimens.

Variety diagnosis.—Cyclocoelium (Postpharyngeum) orientale: Size 14.20 to 21.20 by 2.90 to 4.30 millimeters. Intestinal cæca slightly wavy in outline but with smooth outer and inner walls. Eggs 116.5 to 139.3 by 77.0 to 79.0 microns in size (in mounted specimens).

Host.—Totanus eurhinus.

Location.—Cervical air sac.

Locality.—Obando, Bulacan, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 8.

NOTOCOTYLUS INTESTINALIS sp. nov. Plate 2, figs. 1 and 2.

This parasite may be distinguished from *Notocotylus attenuatus* (Rudolphi, 1809), the type species of the genus, by the shape of its body, which is relatively more elongate; in the anterior extent of its vitellaria, which do not reach beyond the middle of the body length; in the length of the cirrus pouch and of the vagina; and in the number and extent of its transverse uterine coils, which are more numerous and do not pass laterally across the intestinal cæca like those of *N. attenuatus,* as figured by Fuhrmann (1928). It resembles more closely *N. chionis* Baylis, 1928, and *N. tachyeretis* Duthoit, 1931, but differs from them in the measurements of its various organs and in the number of its ventral glands.

Description.—Body small, elongate, 2.30 to 3.25 millimeters in length by 0.54 to 0.75 millimeter in maximum width near posterior end; lateral and posterior margins slightly incurved ventrally. Cuticle of both dorsal and ventral surfaces armed with very minute spines that tend to become sparser toward posterior end. Ventral glands almost uniform in size, evaginable, forty-seven to forty-nine in number, arranged in three longitudinal rows, of which the middle row is more advanced ante-

riorly and consists of fifteen glands and the lateral rows of sixteen to seventeen glands each. Oral sucker globular, 0.12 millimeter in diameter; pharynx absent; œsophagus 0.08 to 0.10 millimeter long; intestinal cæca narrow in diameter, slightly wavy in outline, with few short internal diverticula, and reach to near posterior end of body.

Testes at posterior region of body, symmetrical, extracæcal, elongate, deeply lobed, 0.40 to 0.64 by 0.16 to 0.22 millimeter in size. Cirrus sac long, 0.62 to 0.88 by 0.07 to 0.08 millimeter in size; incloses part of seminal vesicle, pars prostatica, and protrusible cirrus; greater length of seminal vesicle in median line, outside of and behind cirrus sac. Genital pore median, immediately behind œsophageal bifurcation.

Ovary median, intertesticular, distinctly lobed, 0.17 to 0.24 by 0.16 to 0.18 millimeter in size. Shell gland immediately anterior to and smaller than ovary. Oviduct arises from anterior border of ovary; uterus with eighteen to twenty transverse coils, between cirrus sac, intestinal cæca, and shell gland; the coils do not pass laterally across inner cæcal walls. Vagina about three-fourths as long as cirrus pouch. Receptaculum seminis apparently absent; Laurer's canal present. Vitellaria distinctly follicular, extracæcal, extending from behind middle of body length to testes; vitelline reservoir and transverse vitelline ducts dorsal to shell gland. Eggs (in mounted specimens) small, oval, operculated, colorless to pale yellow, with a long filament at each pole, 18.7 to 20.5 by 13.7 to 14.5 microns in size not including filaments.

Main portion of excretory system composed of short bladder that divides into two main lateral branches behind ovary; excretory pore median, on dorsal surface near posterior end of body.

Specific diagnosis.—Notocotylus: Body elongate, 2.30 to 3.25 by 0.54 to 0.75 millimeters in size; lateral and posterior margins slightly incurved ventrally. Cuticle armed with very minute closely set spines. Ventral glands forty-seven to forty-nine in number, arranged in three longitudinal rows: middle row more advanced anteriorly, with fifteen glands and each lateral row with sixteen to seventeen glands. Cirrus sac 0.62 to 0.88 by 0.07 to 0.08 millimeter in size; vagina about three-fourths as long as cirrus sac. Ovary and testes deeply lobed. Vitelline glands do not reach anteriorly beyond middle of body length.

Eggs 18.7 to 20.5 by 13.7 to 14.5 microns in size excluding filaments (in mounted specimens).

Host.—Domestic duck.

Location.—Intestine.

Locality.—Pateros, Rizal, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 65.

NOTOCOTYLUS NAVIFORMIS sp. nov. Plate 1, figs. 2 and 3.

Specimens of this trematode were collected together with *N. intestinalis* from the same host. Because of this fact and its small size, it was thought to represent a growing adult form of the latter. It is separated from *N. intestinalis*, however, in view of its possessing a smaller number of ventral glands and in having its genital pore located in front of the œsophageal bifurcation instead of behind that level, as is the case with the other members of the genus.

Description.—Body elongate, 1.60 to 1.80 millimeters in length by 0.43 to 0.56 millimeter in maximum breadth across or in front of testes; lateral and posterior margins slightly incurved ventrally. Cuticle armed with numerous, very minute spines. Ventral glands evaginable, almost uniform in size, thirty-three in number, arranged in three longitudinal rows, of which the middle row is composed of thirteen glands and each lateral row of ten glands. Oral sucker 0.083 to 0.100 by 0.087 to 0.120 millimeter in size; pharynx absent; œsophagus 0.066 to 0.095 millimeter long; intestinal cæca simple, narrow in diameter, and reach to near posterior end of body.

Testes at posterior region of body, symmetrical, extracæcal, deeply lobed, 0.30 to 0.34 by 0.12 to 0.13 millimeter in size. Cirrus sac 0.36 to 0.40 by 0.035 to 0.040 millimeter in size; incloses terminal portion of long seminal vesicle, pars prostatica, and cirrus; greater length of seminal vesicle in median line, outside of and behind cirrus sac. Genital pore median, midway between oral sucker and œsophageal bifurcation.

Ovary median, between testes, three- to six-lobed, measures 0.12 to 0.14 by 0.10 to 0.12 millimeter. Shell gland smaller than and immediately in front of ovary. Oviduct arises from anterior border of ovary; uterus with fifteen to eighteen transverse coils, between cirrus sac, intestinal cæca, and shell gland; vagina about four-fifths as long as cirrus sac. Receptaculum seminis absent, Laurer's canal present. Vitellaria follicular,

extracæcal, extending from behind middle of body length to testes; vitelline reservoir and transverse vitelline ducts dorsal to shell gland. Eggs (in mounted specimens) colorless to pale yellow, operculated, with long filaments at each pole, 17.8 to 20.8 by 12.5 microns in size, excluding filaments.

Excretory bladder short, divides into two main lateral branches behind ovary and opens outside through excretory pore on dorsal surface near posterior end of body.

Specific diagnosis.—Notocotylus: Body elongate, 1.60 to 1.80 by 0.43 to 0.56 millimeters in size, its lateral and posterior margins slightly incurved ventrally. Cuticle armed with very minute spines. Ventral glands thirty-three in number, arranged in three longitudinal rows, the middle row with thirteen and each lateral row with ten glands. Vagina about four-fifths as long as cirrus sac, which measures 0.36 to 0.40 by 0.035 to 0.040 millimeter. Ovary and testes distinctly lobed. Genital pore median, midway between oral sucker and œsophageal bifurcation. Eggs 17.8 to 20.8 by 12.5 microns in size, excluding filaments (in mounted specimens).

Host.—Domestic duck.

Location.—Intestine.

Locality.—Pateros, Rizal, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 66.

DISTOMES

PHILOPHTHALMUS PROBLEMATICUS sp. nov. Plate 3, fig. 1.

Two adult specimens of this fluke were collected by Dr. Estefano C. Farinas, of the Philippine Bureau of Animal Industry, from the right conjunctival sac of a Rhode Island Red hen in Paco, Manila. The bird was imported from the United States less than a year ago, and it could not be determined where she picked up the parasite.

Of the two specimens collected, only one is available for study, the other having been lost. Comparing this one specimen after it had been stained and mounted in balsam with the other members of the genus *Philophthalmus*, especially with *P. gralli* of chickens as described by Mathis and Leger (1910) from Tonkin and by Sugimoto (1928) from Formosa, it is seen to present several distinguishing features, the most prominent of which are the length and position of its cirrus sac, the shape and position of the testes, and the size of the eggs. According to Mathis and Leger, the testes of *P. gralli* are ovoid, one imme-

diately behind the other, slightly compressed at their opposed surfaces; the anterior testis, in a specimen measuring 6.0 by 1.736 millimeters, is 0.706 by 0.620 millimeter in size and the posterior testis 0.768 by 0.550 millimeter; the cirrus sac (dimensions not given) is located a little behind and lateral to the acetabulum; the eggs vary in size, those in the first half of the uterus measuring 85 by 39 microns, those in the second half of the uterus 120 by 54 microns, and the freshly laid ones 158 by 70 microns. According to Sugimoto, these structures are as follows: The testes are globular, one immediately behind the other, in a straight line or somewhat obliquely placed, mutually compressed, the anterior testis measuring 0.357 to 0.510 by 0.459 to 0.527 millimeter and the posterior testis 0.391 to 0.459 by 0.544 to 0.612 millimeter; the cirrus sac is 0.918 to 1.108 millimeters long and extends posteriorly much beyond the acetabulum; the eggs are 93.6 to 97.5 by 46.8 to 50.0 microns in size. In the Philippine specimen the testes are much smaller than those of either the Tonkin or Formosan forms, the anterior testis measuring 0.20 by 0.44, the posterior 0.26 by 0.44 millimeter; the cirrus sac is shorter, 0.78 by 0.13 millimeter in size and extends posteriorly just beyond the equator of the acetabulum; the eggs are smaller, those at the terminal portion of the uterus measuring 74.8 to 83.2 by 35.2 to 39.5 microns. In view of these and other minor differences, as set forth in Table 1, the conclusion is that the Philippine specimen represents a distinct species.

Description.—Body attenuated anteriorly, broadly rounded posteriorly, measuring 4.48 millimeters in length by 1.62 millimeters in maximum width behind equator of body. Cuticle unarmed. Suckers well developed; oral sucker subterminal, 0.40 by 0.50 millimeter in size; acetabulum 0.57 by 0.53 millimeter, between anterior and middle thirds of body length. Oral sucker followed immediately by pharynx, 0.38 by 0.46 millimeter in size; œsophagus 0.10 millimeter long; intestinal cæca simple, reaching to near posterior end of body.

Testes postovarial, somewhat semicircular in outline, in posterior fourth of body length, one immediately and slightly obliquely behind the other, reciprocally compressed at point of contact; anterior testis measures 0.20 by 0.44, posterior testis 0.26 by 0.44 millimeter. Cirrus sac 0.78 by 0.13 millimeter in size, dorsal to and on the right side of acetabulum, extending posteriorly just beyond the level of equator of this organ; it incloses a prominent seminal vesicle, cirrus, and poorly developed pars

TABLE 1.—*Species of Philophthalmus.*

Species.	Author and date.	Total size.	Size of oral sucker.	Size of pharynx.	Size of acetabulum.	Length of cirrus sac.
		mm.	*mm.*	*mm.*	*mm.*	*mm.*
P. palpebrarum, Looss, 1899	Looss, 1899	4.0×1.0	a 0.45	a 0.45	a 0.6	Very long; reaches to behind acetabulum.
P. lucipetus (Rud., 1819)	Braun, 1902	7.0×1.7	0.83×0.40	0.295×0.317	0.80×0.93	Long; reaches to immediately behind acetabulum.
P. lacrymosus (Braun, 1897)	Braun, 1902	3.5–4.5 ×1.2–1.7	0.335×0.477	0.600×0.399	0.611×0.733	
P. nocturnus Looss, 1907	Looss, 1907	5.0–7.0 ×1.5–2.5	a 0.43–0.52	0.45×0.35	a 0.65–0.70	1.6
P. gralli Mathis and Leger, 1910	Mathis and Leger, 1910	3.0–6.0 ×0.9–1.7	0.285×0.396		a 0.588	Long; reaches to a little behind acetabulum.
P. gralli Mathis and Leger, 1910	Sugimoto, 1928	4.25–5.27 ×1.36–1.53	0.374–0.408 ×0.289–0.357	0.289–0.34 ×0.221–0.289	0.561–0.765 ×0.510–0.765	0.918–1.108
P. anatinus Sugimoto, 1928	Sugimoto, 1928	3.56–6.51 ×0.84–1.05	0.39–0.51 ×0.36–0.37	0.29–0.34 ×0.27–0.49	a 0.47–0.54	0.867–1.7; reaches to far behind acetabulum.
P. problematicus sp. nov.	Tubangui, the present paper.	4.48×1.62	0.4×0.5	0.38×0.46	0.57×0.53	0.78; extends to equator of acetabulum.
P. rizalensis sp. nov	do	1.73–3.08 ×0.56–0.97	0.175–0.240 ×0.20–0.28	0.18–0.26 ×0.16–0.24	0.28–0.44 ×0.32–0.42	0.54–0.84; reaches to behind acetabulum.

Species.	Author and date.	Shape and size of testes.	Shape and size of ovary.	Vitellaria.	Size of eggs in microns.	Host and locality.
		mm.	*mm.*			
P. palpebrarum, Looss, 1899..	Looss, 1899	----------	Rounded	Tubular	54×31; miracidia without eyespot.	*Corvus corniz*; Egypt.
P. lucipetus (Rud., 1819)	Braun, 1902	Testes unequal; anterior 5-lobed; posterior less clearly lobed.	Rounded, slightly compressed 0.214 across.	Follicular	83–104×31–36, miracidia with eyespots.	*Larus fuscus, L. glaucus*, Europe.
P. lacrymosus (Braun, 1897)..	Braun, 1902	----------	0.323 across	----------	67×23.4; miracidia with eyespots.	*Larus maculipennis*; Brazil.
P. nocturnus Looss, 1907	Looss, 1907	Distinctly lobed	Rounded	Tubular	100×40–50; miracidia with eyespots.	*Athene noctua*; Egypt.
P. gralli Mathis and Leger, 1910.	Mathis and Leger, 1910.	Ovoid; anterior 0.706×0.620; posterior 0.768×0.550.	Rounded, 0.248 across.	do	158×70; miracidia with eyespots.	Domestic chicken; Tonkin.
P. gralli Mathis and Leger, 1910.	Sugimoto, 1928	Globular; anterior 0.357–0.51×0.459–0.527; posterior 0.391–0.459×0.544–0.612.	0.238×0.357	do	93.6–97.5×46.8–50; miracidia with eyespots.	Domestic chicken; Formosa.
P. anatinus Sugimoto, 1928..	Sugimoto, 1928	Globular, anterior 0.3–0.5×0.22–0.47; posterior 0.3–0.4×0.25–0.45.	Spherical; 0.22 across.	do	109–117×58–62; miracidia with eyespots.	Domestic duck; Formosa.
P. problematicus sp. nov.	Tubangui, the present paper.	Compressed; anterior 0.20×0.44; posterior 0.26×0.44.	Slightly compressed, 0.28×0.34.	do	74.8–83.2×35.3–39.5; miracidia with eyespots.	Domestic chicken; Philippines.
P. rizalensis sp. nov.	do	Spherical to compressed, almost equal in size; 0.16–0.28×0.20–0.36	Compressed; 0.10–0.12×0.13–0.20	do	106–112×50–54; miracidia with eyespots.	Domestic duck; Philippines.

[a] Transverse diameter.

prostatica. Common genital pore median, ventral to œsophageal bifurcation.

Ovary near median line, proximate to anterior testis, slightly compressed, with smooth surface, 0.28 by 0.34 millimeter in size. Oviduct arises from posterolateral border of ovary; shell gland lateral to anterior testis; receptaculum seminis and Laurer's canal not evident. Uterus well developed, occupying most of space between acetabulum and testes and extending to lateral margins of body across vitelline glands and intestinal cæca. Vagina about twice as long as cirrus pouch. Vitellaria tubular, extracæcal; they extend from a short distance (about 0.45 millimeter) behind posterior level of acetabulum to first testis, at which level the glands of both sides turn mesially and meet behind ovary. Eggs of characteristic asymmetrical shape, with one pole more pointed than the opposite pole, yellowish, those in distal portion of uterus measuring 74.5 to 83.2 by 35.3 to 39.5 microns; they inclose fully developed miracidia that are each provided with a pigmented eyespot visible near the wider pole of the eggshell.

Excretory pore posteroterminal; excretory bladder Y-shaped, the main stem dividing into two branches behind second testis.

Specific diagnosis.—Philophthalmus: Body 4.48 by 1.62 millimeters in size, anterior end attenuated, posterior end broadly rounded. Cuticle unarmed. Oral sucker 0.40 by 0.50 millimeter in size; acetabulum 0.57 by 0.53 millimeter, between anterior and middle thirds of body length; pharynx almost as large as oral sucker, œsophagus 0.10 millimeter long. Cirrus sac 0.78 by 0.13 millimeter in size, extending posteriorly just beyond level of equator of acetabulum. Uterus well developed extending to lateral margins of body across vitelline glands and intestinal cæca. Vitellaria tubular, reaching anteriorly beyond middle of distance between acetabulum and ovary. Ovary 0.28 by 0.34 millimeter in size, close to anterior testis. Testes semicircular, one obliquely and immediately behind the other. Mature eggs (in mounted specimen) 74.8 to 83.2 by 35.3 to 39.5 microns in size, inclosing fully developed miracidia provided with eyespots.

Host.—Domestic chicken (*Gallus gallus domesticus*).

Location.—Conjunctival sac.

Locality.—? Manila, Philippine Islands.

Type specimen.—Philippine Bureau of Science parasitological collection, No. 67.

PHILOPHTHALMUS RIZALENSIS sp. nov. Plate 3, fig. 2.

As shown in Table 1, this parasite of the Philippine domestic duck is smaller than the other members of the genus *Philophthalmus*. The dimensions of its different organs are also much smaller, but its eggs compare favorably in size with the larger eggs of *P. lucipetus, P. nocturnus, P. gralli,* and *P. anatinus*. It is similar to *P. palpebrarum, P. nocturnus, P. anatinus,* and *P. gralli* in the position of its cirrus pouch, which extends posteriorly much beyond the acetabulum, while in the extent of its vitelline glands that do not reach anteriorly beyond the middle of the distance between the acetabulum and the ovary, it is related to *P. lacrymosus* and *P. lucipetus*.

Description.—Body small, anterior end narrower than posterior end, 1.73 to 3.08 millimeters in length by 0.56 to 0.97 millimeter in maximum width behind equator of body. Cuticle smooth. Suckers well developed; oral sucker subterminal, 0.175 to 0.240 by 0.200 to 0.280 millimeter in size; acetabulum between anterior and middle thirds of body length, measuring 0.28 to 0.44 by 0.32 to 0.42 millimeter. Mouth opening ventroterminal; prepharynx absent; pharynx almost as large as oral sucker, 0.18 to 0.26 by 0.16 to 0.24 millimeter in size; œsophagus 0.04 to 0.07 millimeter in length; intestinal cæca simple, narrow in diameter, reaching to near posterior end of body, one cæcum often shorter than its fellow.

Testes roundish to oval in outline, one immediately and obliquely behind the other, at posterior fourth of body length, their opposed surfaces being flattened; they measure 0.16 to 0.28 by 0.20 to 0.36 millimeter; surface of anterior testis smooth, except at posterior border where there may be a slight notch; surface of posterior testis may also be smooth, but more frequently it is notched in two places so that the organ appears 3-lobed. Cirrus sac slender, only slightly dilated at posterior end, 0.54 to 0.84 by 0.04 to 0.08 millimeter in size, and extends posteriorly much beyond level of acetabulum; incloses prominent seminal vesicle, cirrus, and pars prostatica. Common genital opening median, immediately behind pharynx or ventral to œsophageal bifurcation.

Ovary near median line, pretesticular, transversely oval, 0.10 to 0.12 by 0.13 to 0.20 millimeter in size. Oviduct arises from posterior border of ovary; shell gland compact, to one side of median line, behind ovary; neither receptaculum seminis nor Laurer's canal appears to be present. Uterus moderately de-

veloped, between testes and cirrus pouch; laterally it passes across intestinal cæca, but not beyond vitelline glands. Vagina prominent, slightly coiled, about one and one-half times as long as cirrus sac. Vitellaria tubular, but at times they have the appearance of being acinous or follicular due to dilatation of the walls of the tubes at regular intervals with yolk material; extend from anterior testis to middle of distance between acetabulum and ovary. Mature eggs in distal portion of uterus, yellowish, asymmetrical, one pole more pointed than the opposite pole, each inclosing a well-developed miracidium provided with a pigmented eyespot; in mounted specimens they measure 83.2 to 109.3 by 37.4 to 52.0 microns, in the fresh state 106 to 112 by 50 to 54 microns.

Excretory bladder Y-shaped; main stem short but roomy, divides into two main lateral branches behind second testis. Excretory pore posteroterminal.

Specific diagnosis.—Philophthalmus: Body small, measuring 1.73 to 3.08 by 0.56 to 0.97 millimeters. Cuticle unarmed. Oral sucker 0.175 to 0.240 by 0.200 to 0.280 millimeter in size; acetabulum 0.28 to 0.44 by 0.32 to 0.42 millimeter, between anterior and middle thirds of body length; pharynx 0.18 to 0.26 by 0.16 to 0.24 millimeter; œsophagus 0.04 to 0.07 millimeter long. Cirrus sac slender, 0.54 to 0.84 by 0.04 to 0.08 millimeter in size, extends posteriorly much beyond acetabulum. Testes roundish to oval, one immediately and obliquely behind its fellow, the posterior testis often 3-lobed. Vitellaria tubular, not reaching anteriorly beyond middle of distance between ovary and acetabulum. Mature eggs inclose miracidia with pigmented eyespots and measure 106 to 112 by 50 to 54 microns (freshly laid).

Host.—Domestic duck.

Location.—Conjunctival sac.

Locality.—Pateros, Rizal, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 80.

LEUCOCHLORIDIUM HYPOTÆNIDIARUM sp. nov. Plate 4, figs. 1 and 2.

This constitutes the second species of *Leucochloridium* to be described from the Philippines, the first species being *L. dasylophi* Tubangui, 1928, a parasite of the rough-crested cuckoo, *Dasylophus superciliosus*. The two forms differ from each other in many respects, but especially in the character of the cuticle

and in the posterior extent of the vitelline glands. The cuticle of *L. dasylophi* is armed with delicate spines and its vitelline glands extend only as far as the level of the ovary; the cuticle of *L. hypotænidiarum,* on the other hand, is unarmed and its vitelline glands reach posteriorly much beyond the level of the posterior testis, almost as far as the blind ends of the intestinal cæca. Compared further with the other species of the genus, as summarized by McIntosh (1927), the present form is found to agree with *L. soræ* in the extent of its vitellaria, in the arrangement of the ovary and testes, and in the position of the acetabulum and of the genital pore. It differs from *L. soræ,* however, in having a less-elongated body, a larger cirrus pouch, better-developed vitelline follicles, and testes that are almost similar in size.

Description.—Body oval to elongate, 1.95 to 3.46 millimeters in length by 0.97 to 1.56 millimeters in maximum breadth across or immediately behind acetabulum. Cuticle unarmed. Oral sucker rounded or slightly oval transversely, ventroterminal, 0.48 to 0.62 by 0.60 to 0.70 millimeter in size. Acetabulum more or less rounded, at, or more frequently slightly anterior to, middle of body length, 0.60 to 0.72 by 0.54 to 0.76 millimeter in size. Mouth large, leads through narrow passage to oval pharynx measuring 0.16 to 0.18 by 0.20 to 0.24 millimeter; œsophagus absent; intestinal cæca simple, arched on each side of pharynx, and reach to near posterior end of body, where they are often more dilated in diameter.

Testes small, transversely oval, with smooth margins, one obliquely behind the other, intercæcal, about midway between acetabulum and posterior end of body; anterior testis measures 0.13 to 0.15 by 0.24 to 0.28, posterior testis 0.14 to 0.18 by 0.20 to 0.27 millimeter. Cirrus sac at posterior region of body, median, thick walled, oval, 0.20 to 0.34 by 0.12 to 0.18 millimeter in size; incloses pars prostatica and protrusible cirrus; seminal vesicle poorly developed, outside and in front of cirrus sac. Genital pore median, dorsal, near posterior end of body.

Ovary oval, to one side of median line, in front of and very proximate to posterior testis, 0.16 to 0.22 by 0.20 to 0.30 millimeter in size. Oviduct arises from mesial border of ovary; shell gland median, smaller than ovary, located in wedge-shaped area between ovary and second testis; Laurer's canal directed posteriorly from oötype complex; receptaculum seminis not ap-

parent. Uterus very profuse, occupying most of intercæcal space not otherwise occupied by other structures; it is limited anteriorly by intestinal branches, although in rare cases a few uterine loops extend beyond the cæcal arches; posteriorly it crowds out the genital glands. In some of the large specimens examined (Plate 4, fig. 2), the uterine loops are so crowded together that it is impossible to make out their arrangement; in other cases, especially in smaller specimens (Plate 4, fig. 1), the uterus is seen to be composed of short, ascending and descending transverse loops, located on opposite sides of the median line and separated by a short longitudinal space in the acetabular region. Vagina short, leads to genital opening beside cirrus sac. Vitellaria follicular, well developed, mostly extracæcal, extending from level of pharynx or slightly beyond to almost as far as the blind terminals of the intestinal cæca; transverse vitelline ducts at level of second testis; vitelline reservoir median, immediately behind shell gland. Mature eggs (in mounted specimens) oval, operculated, yellowish brown, 22.5 to 25.0 by 14.5 to 16.5 microns in size.

Excretory pore dorsal, in front of genital opening.

Specific diagnosis.—Leucochloridium: Body oval to elongate, 1.95 to 3.46 by 0.97 to 1.56 millimeters in size. Cuticle unarmed. Acetabulum at or a little anterior to equator of body, larger than oral sucker. Reproductive glands near together, about midway between acetabulum and posterior end of body, the ovary in front of second testis on one side of median line and first testis on opposite side. Cirrus sac oval, 0.20 to 0.34 by 0.12 to 0.18 millimeter. Genital pore median, dorsal, near posterior end of body. Vitellaria well developed, mostly extracæcal, from level of pharynx or slightly beyond to almost the blind terminals of intestinal cæca. Eggs 22.5 to 25.0 by 14.5 to 16.5 microns in size (in mounted specimens).

Hosts.—Hypotænidia striata (type host) and *Turnix fasciata.*

Location.—Intestine.

Locality.—Novaliches, Rizal, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 68.

GLAPHYROSTOMUM RALLINARUM sp. nov. Plate 5, fig. 1.

The systematic position of this trematode in the subfamily Harmostominæ Braun, 1900, as defined by Witenberg (1925), is somewhat doubtful. Taking into consideration the characters

used in the subdivision of the subfamily into genera, it is found that the parasite agrees with members of the genera *Harmostomum, Glaphyrostomum,* and *Urotocus* in the shape of its body; with those of *Urotocus* and *Leucochloridium* in the posterior extent of its vitelline glands; with those of *Ithyogonimus* and *Scaphyostomum* in the anterior extent of its uterus; and with those of *Ithyogonimus* and *Glaphyrostomum* in the position of its genital pore. On the other hand, it differs from members of *Harmostomum* in the position of its genital pore, the posterior extent of its vitellaria, and the anterior limit of its uterus; from those of *Urotocus* and *Leucochloridium* in the position of its genital pore; and from those of *Ithyogonimus* and *Scaphyostomum* in the shape of its body and the posterior extent of its vitelline glands. It seems to fit most closely in *Glaphyrostomum* Braun, 1901, differing from members of this genus only in the extent of its vitellaria and uterine coils, which characters may be considered of specific rather than of generic importance. The writer agrees with Werby (1928) that there is need of revising this group of trematodes.

Description.—Body elongate, tongue-shaped, 4.92 millimeters in length by 1.46 millimeters in maximum breadth across or in front of first testis (measurements based on three specimens of a uniform size). Cuticle smooth. Oral sucker ventroterminal, cup-shaped, 0.62 by 0.66 millimeter in size; acetabulum circular, 0.80 to 0.90 millimeter in diameter, between anterior and middle thirds of body length. Mouth opening wide, ventroterminal; pharynx oval, 0.22 to 0.24 by 0.21 to 0.22 millimeter in size; œsophagus absent; intestinal cæca arched on each side of pharynx, narrow in diameter, slightly wavy in their course, and extend to near posterior end of body.

Reproductive glands close together at posterior region of body. Testes distinctly lobed, one almost immediately or slightly obliquely behind the other, separated by a space less than one-half of the diameter of either one of them; anterior testis four- to five-lobed, 0.42 to 0.50 by 0.50 millimeter in size; posterior testis three- to four-lobed, 0.28 to 0.46 by 0.47 to 0.52 millimeter. Cirrus pouch elongate, slightly bent, strongly muscular, 0.45 to 0.50 by 0.10 to 0.12 millimeter in size, its bulk between anterior testis and ovary; incloses long protrusible cirrus. Seminal vesicle long, coiled, outside of cirrus sac. Genital pore ventral, median, at intertesticular level.

Ovary intertesticular, to one side of median line opposite anterior testis, divided transversely into anterior and posterior lobes, each of which may be again divided indistinctly into minor lobes; it measures 0.34 to 0.36 by 0.26 to 0.30 millimeter. Shell gland median, smaller than ovary, beside the latter and in front of posterior testis; Laurer's canal long, narrow, directed posteriorly from oötype complex; receptaculum seminis absent. Uterus confined within intercæcal space, extending anteriorly up to acetabulum and posteriorly up to ovary and first testis; it has probably two series of short transverse coils like the majority of Harmostominæ, but the coils are so crowded together that they cannot be distinguished. Vitellaria follicular, extracæcal, extending from posterior level of acetabulum to level of ovary; transverse vitelline ducts and vitelline reservoir in front of posterior testis. Eggs (in mounted specimens) numerous, operculated, yellowish brown, 22.0 to 25.0 by 13.7 to 14.5 microns in size.

Excretory pore dorsal, near posterior end of body, immediately behind level of posterior testis.

Specific diagnosis.—Glaphyrostomum: Body elongate, 4.92 to 1.46 millimeters in size. Cuticle smooth. Ovary and testes distinctly lobed, the former on one side of median line, opposite latter. Anterior extent of uterus up to acetabulum. Vitellaria from posterior level of acetabulum to level of ovary. Eggs (in mounted specimens) 22.0 to 25.0 by 13.7 to 14.5 microns in size.

Host.—Rallina eurizonoides.

Location.—Intestine.

Locality.—Novaliches, Rizal, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 69.

PSILOCHASMUS LONGICIRRATUS Skrjabin, 1913. Plate 5, fig. 2.

Four out of ten domestic ducks brought from Pateros, Rizal, were found lightly infested with an interesting trematode belonging to the genus *Psilochasmus* Lühe, 1909, emend. Odhner, 1913. The specimens collected differ from *P. oxyurus* (Creplin, 1825), the type species of the genus, in the length of the cirrus pouch and in the anterior extent of the vitelline glands. They also differ from *P. agilis* Travassos, 1925, in the anterior extent of the vitellaria, in the posterior extent of the cirrus pouch and in the size of the testes; and from *P. lecithosus* Otte, 1926, of the domestic duck in Germany in being smaller and in possess-

ing lobed testes. They resemble *P. longicirratus* Skrjabin, 1913, a parasite of *Fuligula nyroka* in Russian Turkestan, most closely and are probably identical with it.

Description.—Body small, elongate, attenuated at both ends, the posterior extremity narrowing abruptly into a protrusible and retractile tail-like process (this region of the body is well supplied with circular muscle fibers); length 3.30 to 4.32 millimeters, maximum width 0.65 to 1.13 millimeters, behind middle of body length. Cuticle unarmed. Oral sucker subterminal, 0.24 to 0.28 by 0.22 to 0.28 millimeter in size. Acetabulum between anterior and middle thirds of body length, bulges prominently from ventral surface, is provided with a sphincter, and measures 0.46 to 0.50 by 0.40 to 0.50 millimeter. Mouth subterminal, separated from pharynx by short prepharynx 0.016 to 0.066 millimeter long; pharynx 0.16 to 0.20 by 0.17 to 0.18 millimeter in size; œsophagus 0.20 to 0.60 millimeter long; intestinal cæca simple, narrow in diameter, extending posteriorly just in front of posterior level of vitelline glands.

Testes postequatorial, postovarial, tandem, close together, oval, either smooth or slightly lobed; anterior testis measures 0.37 to 0.46 by 0.25 to 0.38 millimeter, posterior testis 0.39 to 0.48 by 0.23 to 0.34 millimeter. Cirrus sac very elongate, slightly enlarged posteriorly, 1.00 to 1.30 by 0.10 to 0.16 millimeters in size and extends from genital pore to posterior level of ovary; incloses a prominent seminal vesicle and protrusible cirrus. Common genital pore preacetabular, usually to left side of median line.

Ovary spherical, median, immediately postequatorial, 0.12 to 0.16 millimeter in diameter. Shell gland between ovary and anterior testis; receptaculum seminis absent, Laurer's canal present. Uterus relatively short, with few coils, between anterior testis, intestinal cæca, and acetabulum. Vitellaria distinctly follicular, mostly extracæcal, extending from immediately behind posterior level of acetabulum to behind second testis where the follicles of the two sides unite. Eggs usually few, oval, yellowish, operculated, thin shelled, averaging in mounted specimens 91.5 by 58.2 microns in size.

Excretory system conforms in principle to description by Odhner (1913) of the excretory system of members of the genus *Psilochasmus*. A subcutaneous network of small vessels, which are especially prominent in the anterior portion of the body, is

present. An excretory sinus dorsal to the acetabulum is not visible in the specimens studied, but a median, narrow duct is present behind the second testis and opens outside through an excretory pore located at the tip of the protrusible, posterior, tail-like process.

Host.—Domestic duck.

Location.—Intestine.

Locality.—Pateros, Rizal, Luzon.

ECHINOSTOMA CHLOROPODIS var. PHILIPPINENSIS var. nov. Plate 6, fig. 1, and text fig. 1.

Specimens of this fluke were collected on various occasions from the small intestine of moor hens (*Gallinula chloropus* Linnæus) caught in Laguna de Bay in the vicinity of Los Baños, Laguna. As its proposed name indicates, it bears a very close resemblance to *Echinostoma chloropodis* (Zeder, 1800), reported from the same host in Europe. It differs from the latter, as described by Dietz (1910), only in the number and size of the collar spines and in the size of the eggs and of the various internal organs.

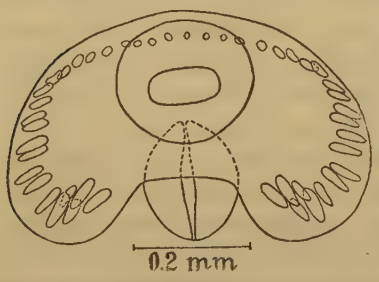

FIG. 1. *Echinostoma chloropodis* var. *philippinensis* var. nov., cephalic collar and spines.

Description.—Body large, elongate, 7.55 to 10.00 by 1.05 to 1.22 millimeters in size, its lateral margins between suckers slightly inrolled ventrally. Cuticle of ventral surface from anterior end to acetabulum armed with spines. Oral sucker subterminal, small, measuring 0.20 to 0.26 by 0.22 to 0.26 millimeter; acetabulum large, cup-shaped, 0.70 to 0.78 millimeter from anterior end of body, 0.89 to 0.93 by 0.80 to 0.83 millimeter in size. Head collar well developed, reniform, 0.40 to 0.50 by 0.60 to 0.73 millimeter in size, armed with forty-six to forty-seven spines arranged in two alternating rows, which may be grouped as follows: four blunt, large, ventral, corner spines on each side, measuring 66.5 to 70.7 by 20.8 to 21.6 microns, and thirty-eight to thirty-nine dorsal and lateral spines that are smaller and measure 33.2 to 62.4 by 12.5 to 16.6 microns (dorsal spines smallest). Prepharynx absent; pharynx 0.21 to 0.24 by 0.16 to 0.19 millimeter in size; œsophagus 0.28 to 0.32 millimeter long, bifurcates immediately behind anterior

border of acetabulum; intestinal cæca narrow in diameter, extend to near posterior end of body.

Reproductive glands in middle of body length. Testes elongate, with slightly indented margins, tandem, median, postovarial, nearly similar in size, measuring 0.58 to 0.71 by 0.26 to 0.31 millimeter. Cirrus sac relatively small, oval, measures 0.24 by 0.17 millimeter, in front of equator of acetabulum, barely protruding anteriorly beyond anterior border of latter; incloses seminal vesicle, cirrus, and pars prostatica. Common genital pore median, immediately preacetabular, in front of œsophageal bifurcation.

Ovary globular, median, 0.31 to 0.38 millimeter in diameter. Oviduct arises from posterior border of ovary; shell gland prominent, as big as or even larger than ovary, between latter and anterior testis; receptaculum seminis absent, Laurer's canal present. Uterus moderately developed, intercæcal, from ovary to acetabulum. Vitellaria follicular, extending from middle of acetabulum or slightly behind that level to near posterior end of body, as far as blind terminals of intestinal cæca; follicles of two sides do not intermingle behind posterior testis; transverse vitelline ducts and vitelline reservoir dorsal to shell gland. Eggs oval, operculated, thin shelled, yellowish, 101 to 104 by 65 to 75 microns in size (in mounted specimens).

Excretory pore median, posteroterminal; excretory bladder Y-shaped, the stem with several side branches and dividing into two main branches behind second testis.

Variety diagnosis.—Echinostoma chloropodis: Head collar with forty-six to forty-seven spines; four ventral corner spines on each side, measuring 66.5 to 70.7 by 20.8 to 21.6 microns; rest of spines, thirty-eight to thirty-nine in number, 33.2 to 62.4 by 12.5 to 16.6 microns in size. Acetabulum 0.70 to 0.78 millimeter from anterior end, 0.89 to 0.93 by 0.80 to 0.83 millimeter in size. Ovary 0.31 to 0.38 millimeter across; testes slightly indented, 0.58 to 0.71 by 0.26 to 0.31 millimeter in size; cirrus sac 0.24 by 0.17 millimeter. Eggs in mounted specimens 101 to 104 by 65 to 75 microns.

Host.—Gallinula chloropus.

Location.—Small intestine.

Locality.—Los Baños, Laguna, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 5.

ECHINOSTOMA BATANGUENSIS sp. nov. Plate 6, fig. 2, and text fig. 2.

Although only one specimen of this fluke is available for description, it is here proposed as a new species. It differs from all known echinostomes, the descriptions of which are available to the writer, in the large number of its collar spines.

Description.—Body elongate, 5.94 by 1.19 millimeters in size; lateral margins between suckers slightly inrolled ventrally. Cuticle of ventral surface up to acetabulum armed with spines. Oral sucker measures 0.25 by 0.24 millimeter; acetabulum 0.68 millimeter from anterior end of body, 1.10 by 0.90 millimeters in size. Head collar reniform, 0.76 millimeter across, armed with seventy-two spines arranged in two alternating rows and measuring 37.5 to 58.2 by 18.7 to 24.9 microns in size, the dorsal spines being the smallest.

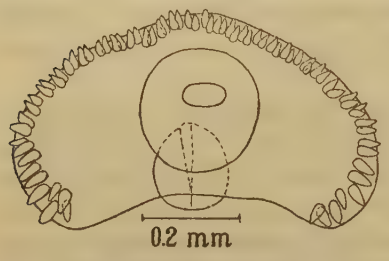

FIG. 2. *Echinostoma batanguensis* sp. nov., cephalic collar and spines.

Pharynx 0.18 by 0.16 millimeter in size; œsophagus 0.18 millimeter long, bifurcates in front of acetabulum; intestinal cæca simple, extending to near posterior end of body.

Testes tandem, small, oval, postovarial, almost similar in size, anterior testis measuring 0.46 by 0.32 and posterior testis 0.44 by 0.30 millimeter. Cirrus sac small, oval, 0.40 by 0.22 millimeter in size, in front of equator of acetabulum, barely extends anteriorly beyond margin of latter. Common genital pore median, between acetabular margin and œsophageal bifurcation.

Ovary compressed, equatorial, 0.22 by 0.34 millimeter in size. Oviduct arises from posterior border of ovary; shell gland as large as ovary, between latter and anterior testis; receptaculum seminis absent, Laurer's canal present. Uterus moderately developed, intercæcal, mostly between ovary and acetabulum. Vitellaria follicular, from posterior level of acetabulum to posterior end of body, beyond blind terminals of intestinal cæca; vitelline follicles of two sides unite behind second testis. Eggs oval, yellowish, operculated, 80.0 to 85.0 by 58.0 to 62.5 microns in size (in mounted specimens).

Excretory pore posteroterminal; excretory bladder long, narrow, with several side branches, and divides into two main branches behind second testis.

Specific diagnosis.—Echinostoma: Body elongate, 5.94 by 1.19 millimeters in size. Oral sucker 0.25 by 0.24 millimeter; acetabulum 0.68 millimeter from anterior end, 1.10 by 0.90 millimeters in size. Head collar 0.76 millimeter across, armed with seventy-two spines measuring 37.5 to 58.2 by 18.7 to 24.9 microns. Testes oval, about equal in size; cirrus sac 0.40 by 0.22 millimeter in size. Eggs 80.0 to 85.0 by 58.0 to 62.5 microns (in mounted specimen).

Host.—Gallinula chloropus.

Location.—Small intestine.

Locality.—Batangas, Batangas, Luzon.

Type specimen.—Philippine Bureau of Science parasitological collection, No. 4.

ECHINOSTOMA REVOLUTUM (Froelich, 1802) Dietz, 1909. Plate 7, fig. 1, and text fig. 3.

Synonym: Echinostoma echinatum (Zeder, 1803) of several authors.

A single specimen of this trematode was collected from the cæcum of a domestic duck from Pateros, Rizal, Luzon. It agrees in many important respects, especially in the number and grouping of the collar spines, with *Echinostoma revolutum*, as described by Looss (1899), Dietz (1910), and Johnson (1920). It most probably represents a young growing adult of this species, as attested by the length of its uterus which contains only a few coils and eggs.

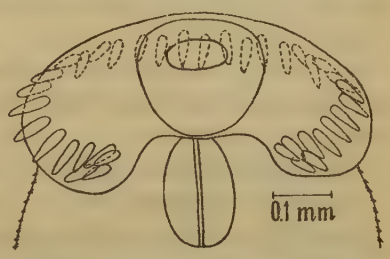

FIG. 3. *Echinostoma revolutum* (Froelich, 1802), cephalic collar and spines.

Description.—Body elongate, 5.83 millimeters in length by 0.97 millimeter in maximum breadth across equator of body; lateral margins between suckers slightly inrolled ventrally. Cuticle of ventral surface from anterior end to level between testes and of dorsal surface from anterior end to acetabulum, armed with spines. Oral sucker measures 0.21 by 0.22 millimeter; acetabulum about 1.0 millimeter from anterior end of body and 0.54 millimeter in diameter. Head collar reniform, 0.60 millimeter across, armed with thirty-seven spines arranged in two alternating rows and grouped as follows: Four corner ventral spines on each side, of which the inner pairs are 52.0 to 60.0 by 16.6 to 17.8 microns in size; the rest of the corner

spines as well as the lateral and dorsal spines are larger and measure 62.5 to 72.8 by 16.6 to 20.8 microns. Pharynx 0.18 by 0.12 millimeter in size; œsophagus 0.42 millimeter long, bifurcates in front of acetabulum; intestinal cæca long, simple, reaching to near posterior end of body.

Testes small, tandem, postovarial, lobed, anterior testis 0.28 by 0.40 millimeter and posterior testis 0.32 by 0.38 millimeter in size. Cirrus sac measures 0.24 by 0.19 millimeter, its greater volume in area between acetabulum and œsophageal bifurcation; incloses coiled seminal vesicle, pars prostatica, and cirrus. Common genital opening median, immediately behind œsophageal bifurcation.

Ovary compressed, immediately postequatorial, 0.16 by 0.27 millimeter in size. Shell gland larger than and behind ovary; receptaculum seminis absent, Laurer's canal present. Uterus short, with few coils and eggs. Vitelline follicles extend from behind level of acetabulum to near posterior end of body, about as far as the blind terminals of the intestinal cæca; follicles of two sides unite behind second testis. Eggs yellowish, oval, operculated, 91.5 to 99.8 by 54.0 to 58.2 microns in size (in mounted specimens).

Excretory bladder long, somewhat dilated posteriorly and divides into two main branches behind second testis; excretory pore posteroterminal.

Host.—Domestic duck.

Location.—Cæcum.

Locality.—Pateros, Rizal, Luzon.

ECHINOPARYPHIUM RECURVATUM (v. Linstow, 1873) Dietz, 1909. Plate 7, fig. 2, and text fig. 4.

Domestic ducks from Pateros, Rizal, are often lightly infested with a small echinostome that differs from *Echinoparyphium recurvatum,* as described by von Linstow (1873) and by Dietz (1910) in the size of its various organs and eggs. In the number and arrangement of their cephalic spines, however, which characters are considered as most important in the determination of echinostomes in general, the two forms appear identical.

Description.—Body small, elongate, 2.10 to 4.32 millimeters in length by 0.43 to 0.48 millimeter in maximum width across acetabulum; lateral margins of forebody between suckers, which is constantly bent ventrolaterally in preserved specimens, rolled ventrally. Cuticle armed with numerous small spines, ventrally

from anterior end to level of testes and dorsally from anterior end to acetabulum. Head collar 0.28 to 0.30 millimeter in transverse diameter, armed with forty-five spines arranged in two alternating rows and grouped as follows: Four corner, ventral spines on each side, measuring in unstained specimens mounted in glycerine 87.3 to 91.5 by 18.7 to 20.8 microns; thirty-seven lateral and dorsal spines of two sizes, the aboral series measuring 74.8 to 82.8 by 16.6 to 20.8 microns and the oral series 60.3 to 66.5 by 14.5 to 16.6 microns. (The measurements of cephalic spines in stained specimens mounted in balsam are smaller; corner spines 66.5 to 74.8 by 16.6, aboral lateral and dorsal spines 64.2 to 70.7 by 12.5 to 14.5, and oral lateral and dorsal spines 44.0 to 58.0 by 12.5 microns.) Oral sucker measures 0.10 by 0.08 millimeter; prepharynx short or absent; pharynx 0.08 by 0.05 millimeter in size; œsophagus 0.38 to 0.52 millimeter long, bifurcates in front of acetabulum; intestinal cæca simple, narrow in diameter, extend to near posterior end of body.

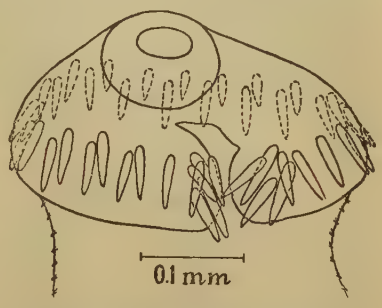

FIG. 4. *Echinoparyphium recurvatum* (von Linstow, 1873), cephalic collar and spines.

Testes oval to elongate, with smooth borders, tandem, very close together, postovarial; anterior testis usually shorter, 0.28 to 0.38 by 0.19 to 0.20 millimeter and posterior testis 0.36 to 0.41 by 0.18 millimeter in size. Cirrus sac 0.20 to 0.24 by 0.08 to 0.09 millimeter in size, extends posteriorly up to but not beyond equator of acetabulum; incloses seminal vesicle, pars prostatica, and cirrus. Common genital opening median, preacetabular, between œsophageal bifurcation and acetabulum.

Ovary median, globular or very slightly compressed, immediately postequatorial, 0.14 to 0.15 millimeter across. Shell gland rounded, slightly larger than ovary, between latter and first testis; receptaculum seminis absent, Laurer's canal present. Uterus very short, with very few eggs. Vitellaria in large follicles, extending from a little in front of level of ovary to near posterior end of body; follicles of two sides unite behind second testis. Eggs oval, yellowish, operculated, 79.0 to 83.5 by 54.0 to 58.2 microns in size (in mounted specimens).

Excretory bladder narrow in diameter, divides into two main branches behind second testis; excretory pore posteroterminal.

Host.—Domestic duck.

Location.—Small intestine.

Locality.—Pateros, Rizal, Luzon.

ECHINOCHASMUS NOVALICHESENSIS sp. nov. Plate 9, fig. 1, and text fig. 5.

This trematode is characterized especially by the size of its collar spines, of which the first two corner ventral ones are smaller and measure 42.4 to 45.7 by 10.4 to 10.8 microns; the rest of the spines are 46.6 to 54.0 by 10.4 to 12.4 microns in size. In the other members of the genus *Echinochasmus* listed by Dietz (1910) and by Odhner (1910), the cephalic spines are either of uniform or dissimilar sizes. If dissimilar, as in the case of *E. coaxatus* Dietz, 1909, the first three corner ventral spines are smaller, 60.0 to 76.8 by 16.8 to 19.2 microns, while the rest are 76.8 to 81.6 by 19.2 to 21.6 microns in size; in the case of *E. euryporus* (Looss, 1896, nec 1899), the spines become slightly larger in size from the dorsal to the ventral series and measure 45 to 54 by 14 to 18 microns.

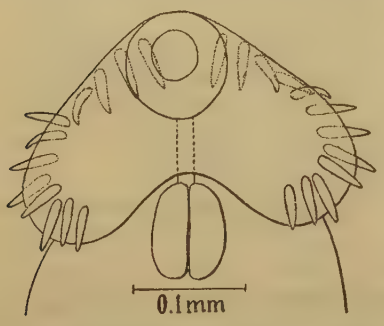

FIG. 5. *Echinochasmus novalichesensis* sp. nov., cephalic collar and spines.

Description.—Body small, elongate, 2.32 to 3.25 millimeters in length by 0.48 to 0.75 millimeter in maximum breadth across first testis; lateral margins between suckers inrolled ventrally. Cuticle armed with prominent, flat, scalelike spines from anterior end to level of first or second testis. Oral sucker terminal to subterminal, 0.08 to 0.10 by 0.10 to 0.12 millimeter in size; acetabulum, 0.22 to 0.26 by 0.25 to 0.32 millimeter, between anterior and middle thirds of body length or slightly anterior to that level. Head collar reniform, 0.26 to 0.32 millimeter across, armed with twenty-four blunt spines arranged in a single, dorsally interrupted row; the first two corner ventral spines on each side of collar are slightly smaller and measure 42.4 to 45.7 by 10.4 to 10.8 microns, the other spines measure 46.6 to 54.0 by 10.4 to 12.4 microns. Oral sucker separated from pharynx by

prepharynx 0.05 to 0.07 millimeter long; pharynx 0.08 to 0.10 by 0.08 to 0.09 millimeter in size; œsophagus 0.24 to 0.32 millimeter long, bifurcates in front of acetabulum; intestinal cæca simple, reaching to near posterior end of body.

Testes postequatorial, postovarial, tandem, with smooth borders, variable in shape and size; anterior testis spherical, oval or transversely elongate, measuring 0.20 to 0.38 by 0.19 to 0.34 millimeter; posterior testis spherical but usually oval to elongate and measures 0.22 to 0.42 by 0.20 to 0.30 millimeter. Cirrus sac oval, 0.16 to 0.32 by 0.10 to 0.18 millimeter in size, the greater part of its bulk projecting beyond anterior border of acetabulum, immediately behind œsophageal bifurcation; incloses small seminal vesicle, cirrus, and pars prostatica; seminal vesicle constricted at middle of its length. Genital pore median between œsophageal bifurcation and acetabulum.

Ovary equatorial or immediately preëquatorial, globular, 0.09 to 0.13 millimeter in diameter, usually to right side of median line; oviduct arises from its posterior border. Shell gland larger than ovary, median, in front of anterior testis; transverse vitelline ducts and vitelline reservoir dorsal, between shell gland and anterior testis; receptaculum seminis absent, Laurer's canal present. Uterus short, with very few eggs. Vitellaria in large, distinct follicles, extending from posterior level of acetabulum to posterior end of body; behind second testis the follicles of two sides are united. Eggs oval, yellowish, thin-shelled, operculated, measuring (in mounted specimens) 95.6 to 108.0 by 58.2 to 70.7 microns.

Excretory bladder long, with four pairs of side branches, and divides into two main branches behind second testis; excretory pore posterosubterminal.

Specific diagnosis.—Echinochasmus: Body 2.32 to 3.25 by 0.48 to 0.75 millimeters in size. Oral sucker measures 0.08 to 0.10 by 0.10 to 0.12 millimeter, acetabulum 0.22 to 0.26 by 0.25 to 0.32 millimeter; pharynx 0.08 to 0.10 by 0.08 to 0.09 millimeter; prepharynx 0.05 to 0.07 and œsophagus 0.24 to 0.32 millimeter long. Cephalic collar 0.26 to 0.32 millimeter across; first two corner ventral cephalic spines on each side smaller, 42.4 to 45.7 by 10.4 to 10.8 microns, the others 46.6 to 54.0 by 10.4 to 12.4 microns in size. Ovary 0.09 to 0.13 millimeter across; testes variable in shape and size. Vitellaria from pos-

terior level of acetabulum to posterior end of body. Eggs 95.6 to 108.0 by 58.2 to 70.7 microns in size (in mounted specimens).

Host.—*Hypotænidia torquata.*

Location.—Small intestine.

Locality.—Novaliches, Rizal, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 105.

HOLOSTOMES

STRIGEA MCGREGORI sp. nov. Plate 8, fig. 1.

The genus *Strigea* Abildgaard, 1790, has recently been divided by Szidat (1929) into six genera which, together with the genus *Apharyngostrigea* Ciurea, 1927, constitute the subfamily Strigeinæ Railliet, 1919. The genus *Strigea* (s. str.) is distinguished from the other genera by the distribution of the vitelline glands in both body regions, by the presence of a pharynx, and by the fact that the forebody is not much thicker than the hindbody. It comprises six well-defined species, with one of which, *S. falconis* Szidat, 1929, the parasite in question is most similar, especially with regard to the posterior extent of the vitellaria, the small size of the genital cone, the lobed testes, and the fact that the suckers are conspicuous. The two forms, however, may be differentiated as follows: *Strigea mcgregori* is much shorter, its ovary and eggs are smaller, its adhesive gland is large and more conspicuous, and the cuticle of its forebody is armed with very minute spines.

This parasite is named for Mr. R. C. McGregor, ornithologist of the Philippine Bureau of Science, who has kindly identified bird hosts for the writer from time to time.

Description.—Total length 1.94 to 2.28 millimeters; forebody distinctly marked off from hindbody, bell- or cup-shaped, 0.58 to 0.74 millimeter long, by 0.60 to 0.84 millimeter thick, the size of the opening of the cup in inverse proportion to the state of contraction of its walls; hindbody curved dorsally, 1.36 to 1.54 by 0.56 to 0.60 millimeters in dimensions. Cuticle of forebody armed with numerous, very minute spines. Oral sucker and pharynx 0.12 to 0.13 and 0.10 millimeter, respectively, in transverse diameter; œsophagus 0.07 millimeter long; acetabulum 0.22 by 0.20 millimeter in size, not hidden by vitellaria. Holdfast organ or attaching apparatus well-developed, attached to base of forebody; distally it is divided into three or more lamellæ which barely protrude beyond margin of cup.

Adhesive gland conspicuous, 0.18 by 0.26 millimeter in size, at junction between forebody and hindbody or a little anterior of that level, dorsal to acetabulum.

Testes compact, lobed (at least three lobes each), tandem, partly overlapping each other, postovarial, immediately behind equator of hindbody, 0.20 to 0.22 millimeter long by 0.33 to 0.36 millimeter thick. Vesicula seminalis well developed, coiled, behind second testis. Common genital pore on tip of small genital cone and communicates with the exterior through roomy sinus of modified bursa at posterior end of body.

Ovary spherical, 0.16 millimeter in diameter, at equator of hindbody. Oviduct arises from posterior border of ovary, is joined by Laurer's canal in front of anterior testis, continues posteriorly, and between the testes it meets with the vitelline duct and shell gland. Uterus moderately long; in some cases it reaches anteriorly up to near limit of hindbody, then bends suddenly ventrad and is continued posteriorly as a more or less straight canal; it leads to genital opening through thick-walled vagina. Vitellaria follicular, found in both regions of body; in forebody the vitelline glands are diffusely distributed, disappearing gradually towards margin of cup; in hindbody they are concentrated anterior and ventral to genital glands, reaching posteriorly only as far as beginning of genital bursa. Eggs oval, yellowish, operculated, thin shelled, 104 to 112 by 82 to 85 microns in size (in mounted specimens).

Specific diagnosis.—Strigea: Total length 1.94 to 2.28 millimeters; forebody 0.58 to 0.74 by 0.60 to 0.84 millimeter, its cuticle armed with minute spines; hindbody 1.36 to 1.54 by 0.56 to 0.60 millimeters. Adhesive gland conspicuous, 0.18 by 0.26 millimeter, at junction of body regions or slightly anterior. Oral sucker and pharynx 0.12 to 0.13 and 0.10 millimeter, respectively, in transverse diameter; œsophagus 0.07 millimeter long; acetabulum 0.22 by 0.20 millimeter. Ovary globular, 0.16 millimeter across, at equator of hindbody. Testes lobed, 0.20 to 0.22 by 0.33 to 0.36 millimeter. Genital sinus roomy, genital cone small. Vitellaria in both body regions, extending posteriorly up to beginning of genital bursa. Eggs 104 to 112 by 82 to 85 microns in size (in mounted specimens).

Host.—Butastur indicus.

Location.—Intestine.

Locality.—Calamba, Laguna, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 3.

PARASTRIGEA INTERMEDIA sp. nov. Plate 8, fig. 2, and Plate 11, figs. 1, 2, and 3.

According to Szidat (1929), the genus *Parastrigea* is similar to *Strigea* in the distribution of the vitellaria and in the form of the genital cone and bursa. It differs from the latter only in the presence of a pair of lateral projections or lobes on the cup-shaped forebody, the entrance into the cavity of which is small. The trematode under consideration possesses these generic characters, differing from *Parastrigea cincta* (Brandes) and *P. robusta* Szidat in that the lateral lobes of its forebody are not so very well developed (Plate 11, fig. 1). For this reason it may be considered as representing an intermediate form between the members of the genus *Strigea* and those of *Parastrigea.* In size it is also intermediate between *P. cincta* and *P. robusta, P. cincta* being the largest.

Description.—Body moderately large, distinctly divided into two regions, with a total length of 4.80 to 5.57 millimeters; forebody more or less triangular in shape, being expanded posteriorly into two not very prominent lateral lobes and measuring 1.78 to 2.00 millimeters in length by 1.10 to 1.45 millimeters in maximum width by 0.95 to 1.00 millimeter in maximum thickness; hindbody bag-shaped, constricted at its junction with forebody, measuring 3.02 to 3.62 by 1.15 to 1.20 by 1.13 to 1.15 millimeters. Oral sucker, pharynx, and acetabulum weakly developed, the latter being very close to pharynx; they measure, respectively, 0.10 to 0.12, 0.12, and 0.14 millimeter in transverse diameter. Holdfast organ well developed, filling up most of cavity of forebody; it appears solid at its base, but distally it is lamellated, the lamellæ usually protruding through narrow opening of forebody (Plate 11, fig. 3). Adhesive gland relatively small, 0.12 by 0.10 millimeter in size, near junction of body regions.

Testes behind equator of hindbody, postovarial, tandem, partly overlapping each other, very slightly lobed if at all, measuring 0.56 by 1.00 millimeter. Common genital pore discharges into cavity of small modified genital bursa at posterior end of body. Genital cone absent.

Ovary transversely oval, 0.36 by 0.54 millimeter in size, at equator of hindbody. Uterus moderately long, with fairly numerous eggs. Laurer's canal present, opens dorsally opposite level of first testis and meets oviduct in front of this organ. Shell gland and vitelline reservoir between testes. Vitellaria very well developed in both body regions; in the forebody they

occur in the lateral walls of the cup in the form of two thin lateral layers and in the substance of the holdfast organ in the form of two symmetrical winglike masses (Plate 11, fig. 2); in the hindbody they fill the regions anterior and ventral to reproductive glands, extending posteriorly up to beginning of bursa or a little beyond. Eggs oval, yellowish, thin shelled, operculated, 99.8 to 112.3 by 70.7 to 79.0 microns in size (in mounted specimens). Excretory pore ventral, near posterior end of body.

Specific diagnosis.—Parastrigea: Total length 4.80 to 5.57 millimeters; forebody 1.78 to 2.00 millimeters in length by 1.10 to 1.45 millimeters in maximum width by 0.95 to 1.00 millimeter in maximum thickness, with rounded, moderately developed lateral lobes; hindbody cylindrical, 3.02 to 3.68 by 1.15 to 1.20 by 1.13 to 1.15 millimeters. Oral sucker, pharynx, and acetabulum weak, measuring, respectively, 0.10 to 0.12, 0.12, and 0.14 millimeter across. Ovary 0.36 by 0.54 millimeter, testes 0.56 by 1.00 millimeter in size. Bursa small, genital cone absent. Vitellaria profuse in both body regions, extending from acetabular level to beginning of bursa. Uterus moderately long. Eggs fairly numerous, 99.8 to 112.3 by 70.7 to 79.0 microns in size (in mounted specimens).

Host.—Butastur indicus.

Location.—Intestine.

Locality.—Calamba, Laguna, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 11.

COTYLURUS MAMILLIFORMIS sp. nov. Plate 10, figs. 1 and 2.

Szidat (1929) in his revision of the genus *Strigea* assigned to his genus *Cotylurus* the following five species of holostomes parasitic in sea gulls and water birds; namely, *C. cornutus* (Rudolphi), *C. aquavis* (Guberlet), *C. erraticus* (Rudolphi), *C. platycephalus* (Creplin), and *C. variegatus* (Creplin). The last four species are said to possess lobed testes, a character that separates them at once from the parasite under consideration. There remains, therefore, only *C. cornutus*, the type species of the genus, which the new species resembles most closely but from which it differs in the more posterior position of its ovary and testes and in the size of the latter organs.

Description.—Body with a total length of 1.32 to 2.96 millimeters, divided distinctly into two regions; forebody 0.36 to 0.66 millimeter in length by 0.58 to 0.64 millimeter in maximum

width by 0.44 to 0.54 millimeter in maximum thickness; hindbody curved dorsally, measuring 0.96 to 2.30 by 0.60 to 0.64 by 0.40 to 0.50 millimeters. Cuticle smooth. Oral sucker ventroterminal, roundish, 0.091 to 0.095 millimeter across; acetabulum 0.130 to 0.175 by 0.140 to 0.175 millimeter, pharynx 0.054 to 0.062 by 0.045 to 0.054 millimeter in size; œsophagus 0.037 to 0.058 millimeter long; intestinal cæca simple, extending posteriorly just beyond vitelline glands. Holdfast organ attached to base of forebody and consisting distally of anterior and posterior lamellæ that protrude beyond ventral rim of cup-shaped forebody. Adhesive gland not very conspicuous, dorsal to acetabulum.

Testes tandem, very close together, immediately postovarial, behind equator of hindbody, transversely elongate, their extremities bent ventrally towards median line, 0.22 to 0.30 by 0.50 to 0.53 millimeter in size. Vesicula seminalis moderately developed; ejaculatory duct short, opens into common genital pore dorsal to vagina. Genital pore at posteroventral wall of sinus of genital bursa at posterior end of body. Genital cone absent.

Ovary slightly compressed, 0.18 to 0.20 to 0.22 millimeter in size, median, at equator of hindbody. Oviduct arises from posterior border of ovary and is soon joined by Laurer's canal which opens on dorsal surface of body at level of anterior testis; it is continued posteriorly and after receiving the vitelline duct and entering the shell gland in the region between the two testes, it bends anteriorly and becomes the uterus; the latter on reaching the level of the ovary turns ventrad and runs in an almost straight line towards the genital pore. Vitellaria in distinct, fairly large follicles, confined in hindbody where they occupy most of the space anterior and ventral to the reproductive glands and extend to near posterior end of body. Eggs few, oval, yellowish, thin shelled, operculated, measuring (in mounted specimens) 87.3 to 99.8 by 58.2 to 66.5 microns.

Excretory pore median, ventral, near posterior end of body.

Specific diagnosis.—Cotylurus: Total length 1.32 to 2.96 millimeters; forebody 0.36 to 0.66 millimeter in length by 0.58 to 0.64 millimeter in maximum width by 0.44 to 0.54 millimeter in maximum thickness, hindbody 0.96 to 2.30 by 0.60 to 0.64 by 0.40 to 0.50 millimeters. Oral sucker 0.091 to 0.095 millimeter across; acetabulum 0.130 to 0.175 by 0.140 to 0.175 millimeter, pharynx 0.054 to 0.062 by 0.045 to 0.054 millimeter in

size; œsophagus 0.037 to 0.058 millimeter long. Ovary 0.18 to 0.20 by 0.20 to 0.22 millimeter in size; testes 0.22 to 0.30 by 0.50 to 0.53 millimeter, behind equator of hindbody, their lateral extremities rolled ventrally. Eggs 87.3 to 99.8 by 58.2 to 66.5 microns in size (in mounted specimens).

Host.—Snipe (*? Gallinago gallinago*).

Location.—Intestine.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 13.

PROALARIA BUTASTURINA sp. nov. Plate 9, fig. 2.

Compared with the species assigned to the genus *Proalaria* by La Rue (1926, 1927), this fluke appears to be most closely related to *P. gavium* (Guberlet, 1922) in the shape and size of the testes and in the extent of the vitellaria. It differs from *P. gavium*, however, in the relative lengths of its two body regions, in the larger size of its holdfast organ, and in possessing a longer œsophagus.

Description.—Body slipper-shaped, 1.36 to 1.60 millimeters in total length, divided into two regions by slight circular constriction; forebody foliaceous, slightly longer than hindbody, 0.76 to 0.90 by 0.42 to 0.50 millimeter in size, its lateral margins incurved ventrally and meeting in median line behind holdfast organ; hindbody thicker, 0.60 to 0.70 by 0.34 to 0.40 millimeter. Cuticle smooth. Oral sucker subterminal, measuring 0.037 to 0.041 by 0.041 to 0.045 millimeter; acetabulum at or immediately in front of middle of forebody, 0.058 to 0.066 millimeter across; pharynx 0.041 millimeter across, œsophagus 0.066 millimeter long; intestinal cæca simple, reaching to near posterior end of body. Lateral earlike appendages, not very prominent, on each side of level of pharynx. Adhesive disc or holdfast organ elliptical, with elongated shallow cavity, 0.20 to 0.34 by 0.12 to 0.18 millimeter in size, in posterior half of forebody, immediately behind acetabulum and bounded laterally by intestinal cæca.

Testes transversely elongate, immediately postovarial, in front of equator of hindbody, 0.04 to 0.10 by 0.18 to 0.28 millimeter in size; they are not unlike a mammalian femur in shape, with their extremities extending laterally across intestinal cæca. Cirrus sac absent. Vesicula seminalis well developed; ejaculatory duct short, leading into dorsally located genital pore near posterior end of body.

Ovary median or very slightly to one side of median line, at junction of two body regions, 0.095 to 0.108 by 0.125 to 0.145 millimeter in size. Uterus short, in many cases extending almost in a straight line from ovary to genital pore. Shell gland and vitelline reservoir between testes. Vitellaria profuse, distributed throughout hindbody and in most of forebody, including holdfast organ, disappearing gradually towards anterior end at level of œsophageal bifurcation. Eggs few, small, colorless, thin shelled, operculated, averaging in mounted specimens 58.2 by 37.5 microns in size.

Excretory system in the form of a network, the details of which could not be determined. There are two prominent longitudinal vessels in the forebody lateral to intestinal cæca; excretory pore posteroterminal.

Specific diagnosis.—Proalaria: Total length 1.36 to 1.60 millimeters; forebody measures 0.76 to 0.90 by 0.42 to 0.50 millimeter, hindbody 0.60 to 0.70 by 0.34 to 0.40 millimeter. Œsophagus 0.066 millimeter long. Holdfast organ elliptical, 0.20 to 0.34 by 0.12 to 0.18 millimeter in size, with shallow cavity. Ovary measures 0.095 to 0.108 by 0.125 to 0.145 millimeter, testes 0.04 to 0.10 by 0.18 to 0.28 millimeter. Vitellaria distributed throughout hindbody and in greater portion of forebody, disappearing gradually up to level of œsophageal bifurcation. Eggs in mounted specimens average 58.2 by 37.5 microns in size.

Host.—Butastur indicus.

Location.—Small intestine.

Locality.—Calamba, Laguna, Luzon.

Type specimens.—Philippine Bureau of Science parasitological collection, No. 14.

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ILLUSTRATIONS

[Drawings by Mr. V. V. Marasigan; microphotographs by Mr. V. Ferrer.]

ABBREVIATIONS

ac, acetabulum.
agl, adhesive gland.
cp, cirrus pouch.
gc, genital cone.
gp, genital pore.
gs, genital sinus.
ho, holdfast organ.
ia, intestinal arch.
lc, Laurer's canal.
œs, œsophagus.
ov, ovary.
sg, shell gland.
t, testis.
ut, uterus.
vag, vagina.
vg, vitelline glands.
vgl, ventral glands.
vr, vitelline reservoir.
vs, vesicula seminalis.

PLATE 1

FIG. 1. *Cyclocoelium* (*Postpharyngeum*) *orientale* var. *eurhinus* var. nov., entire worm, ventral view.
2. *Notocotylus naviformis* sp. nov., number and arrangement of ventral glands.
3. *Notocotylus naviformis* sp. nov., entire worm, ventral view.

PLATE 2

FIG. 1. *Notocotylus intestinalis* sp. nov., entire worm, ventral view.
2. *Notocotylus intestinalis* sp. nov., number and arrangement of ventral glands.

PLATE 3

FIG. 1. *Philophthalmus problematicus* sp. nov., entire worm, ventral view.
2. *Philophthalmus rizalensis* sp. nov., entire worm, ventral view.

PLATE 4

FIG. 1. *Leucochloridium hypotaenidiarum* sp. nov., young adult form, ventral view.
2. *Leucochloridium hypotaenidiarum* sp. nov., large adult form, ventral view.

PLATE 5

FIG. 1. *Glaphyrostomum rallinarum* sp. nov., entire worm, ventral view.
2. *Psilochasmus longicirratus* Skrjabin, 1913, entire worm, ventral view.

PLATE 6

FIG. 1. *Echinostoma chloropodis* var. *philippinensis* var. nov., entire worm, ventral view.
2. *Echinostoma batanguensis* sp. nov., entire worm, ventral view.

PLATE 7

FIG. 1. *Echinostoma revolutum* (Froelich, 1802), entire worm, ventral view.
2. *Echinoparyphium recurvatum* (von Linstow, 1873), entire worm, ventral view.

PLATE 8

FIG. 1. *Strigea mcgregori* sp. nov., entire worm, lateral view.
2. *Parastrigea intermedia* sp. nov., entire worm, lateral view.

PLATE 9

FIG. 1. *Echinochasmus novalichesensis* sp. nov., entire worm, ventral view.
2. *Proalaria butasturina* sp. nov., entire worm, ventral view.

PLATE 10

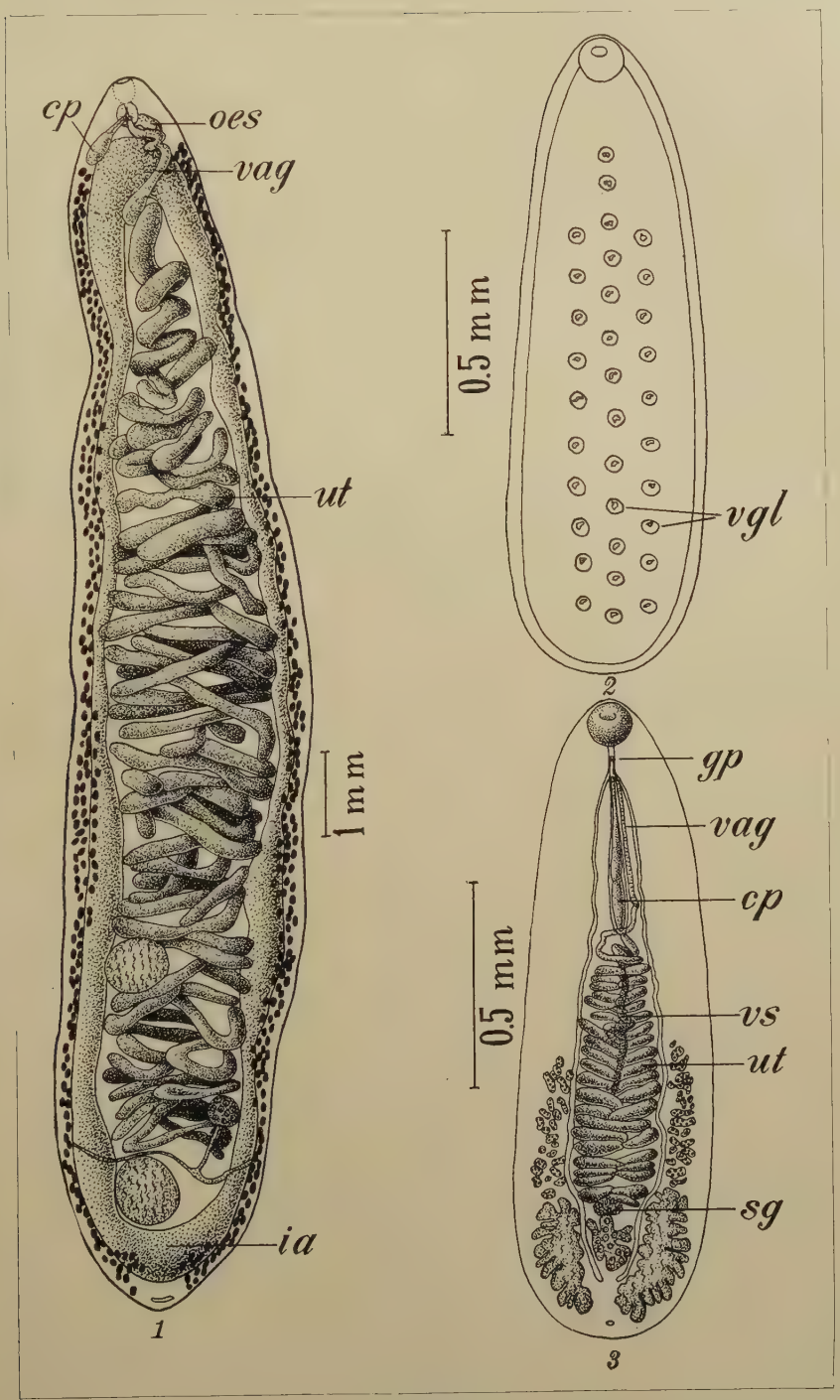
FIG. 1. *Cotylurus mamilliformis* sp. nov., entire worm, lateral view.
2. *Cotylurus mamilliformis* sp. nov., entire worm, ventral view.

PLATE 11

FIG. 1. *Parastrigea intermedia* sp. nov., entire worm showing shape of forebody, dorsal view.
2. *Parastrigea intermedia* sp. nov., cross-section through forebody.
3. *Parastrigea intermedia* sp. nov., median sagittal section.

TEXT FIGURES

FIG. 1. *Echinostoma chloropodis* var. *philippinensis* var. nov., cephalic collar and spines.
2. *Echinostoma batanguensis* sp. nov., cephalic collar and spines.
3. *Echinostoma revolutum* (Froelich, 1802), cephalic collar and spines.
4. *Echinoparyphium recurvatum* (von Linstow, 1873), cephalic collar and spines.
5. *Echinochasmus novalichesensis* sp. nov., cephalic collar and spines.



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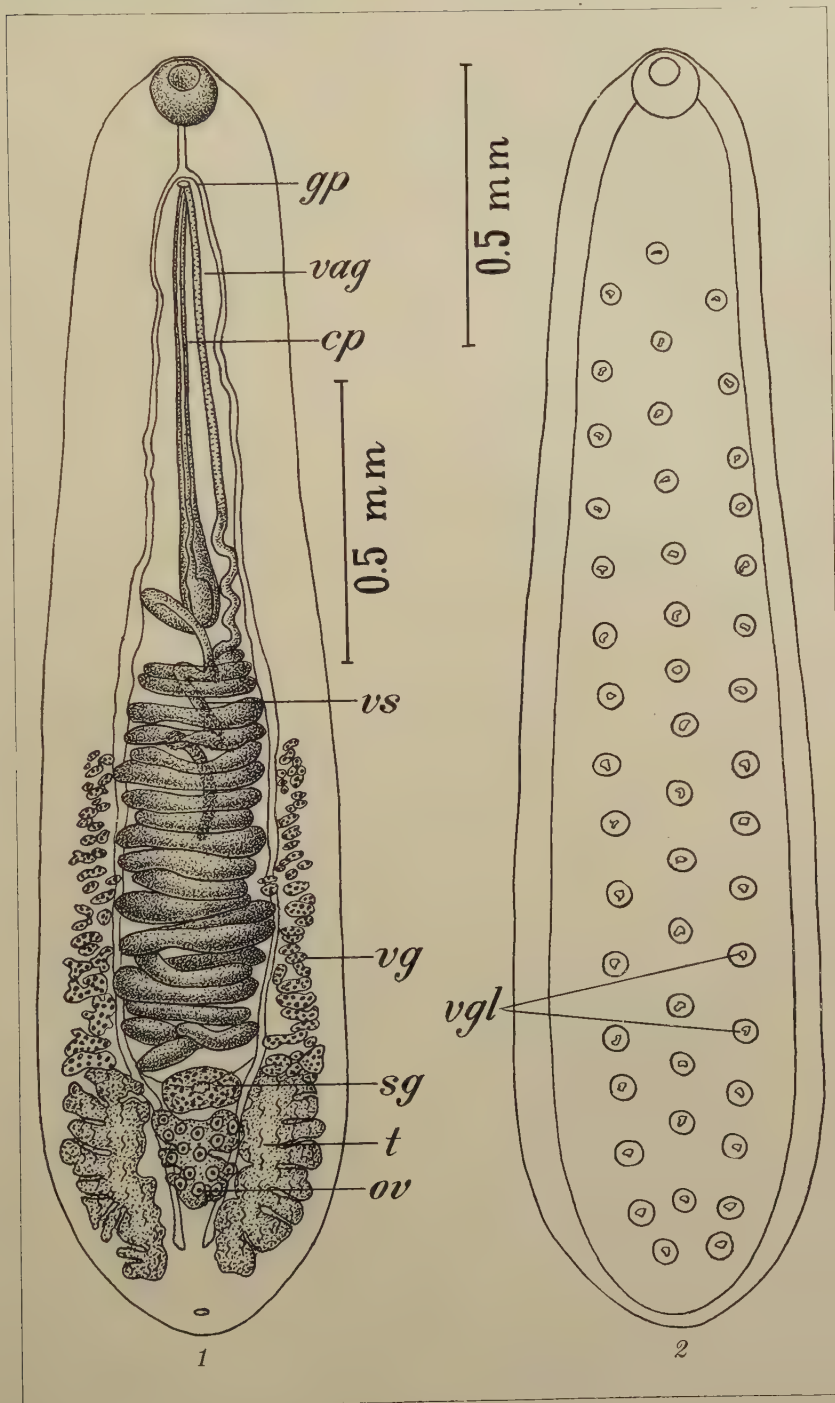

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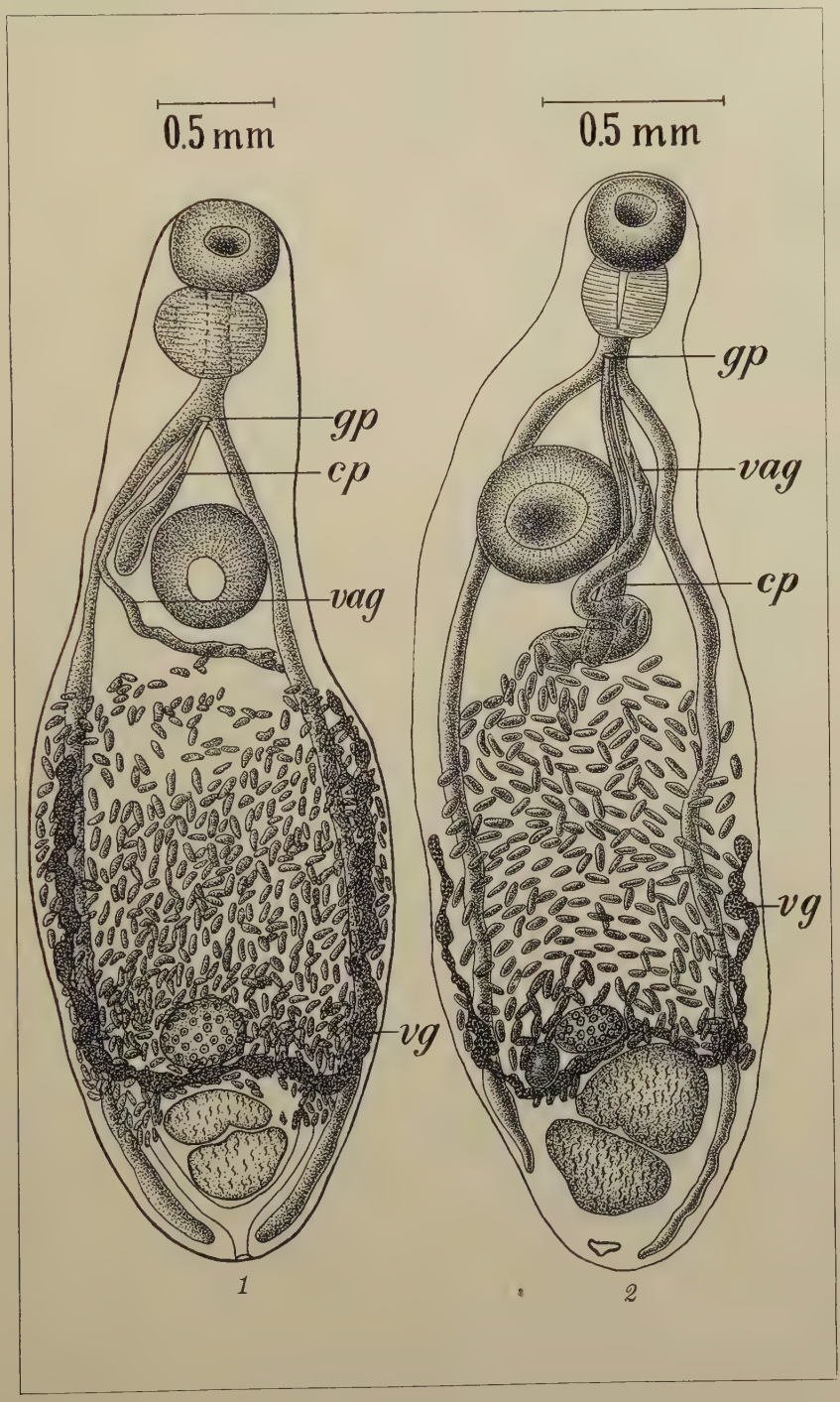

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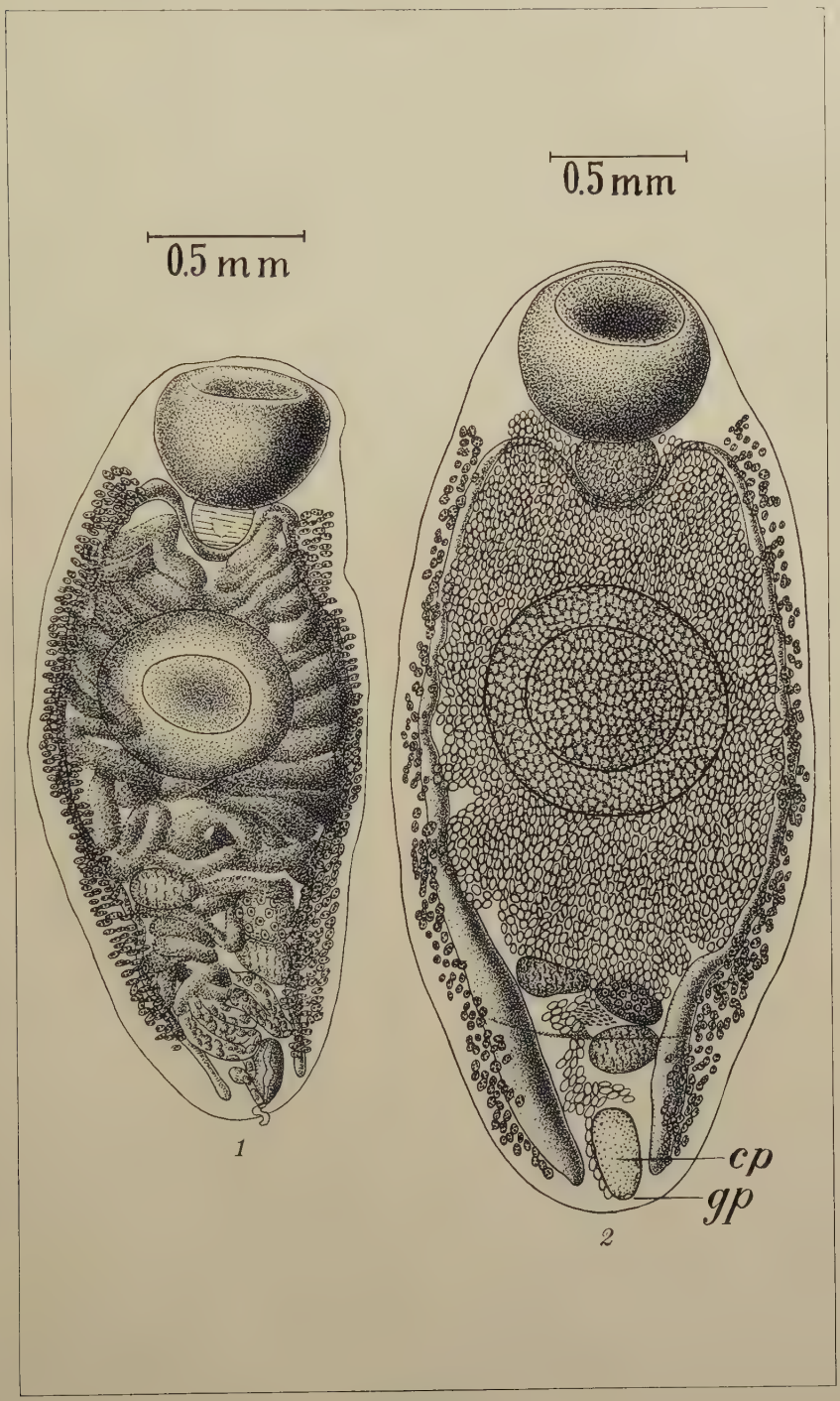

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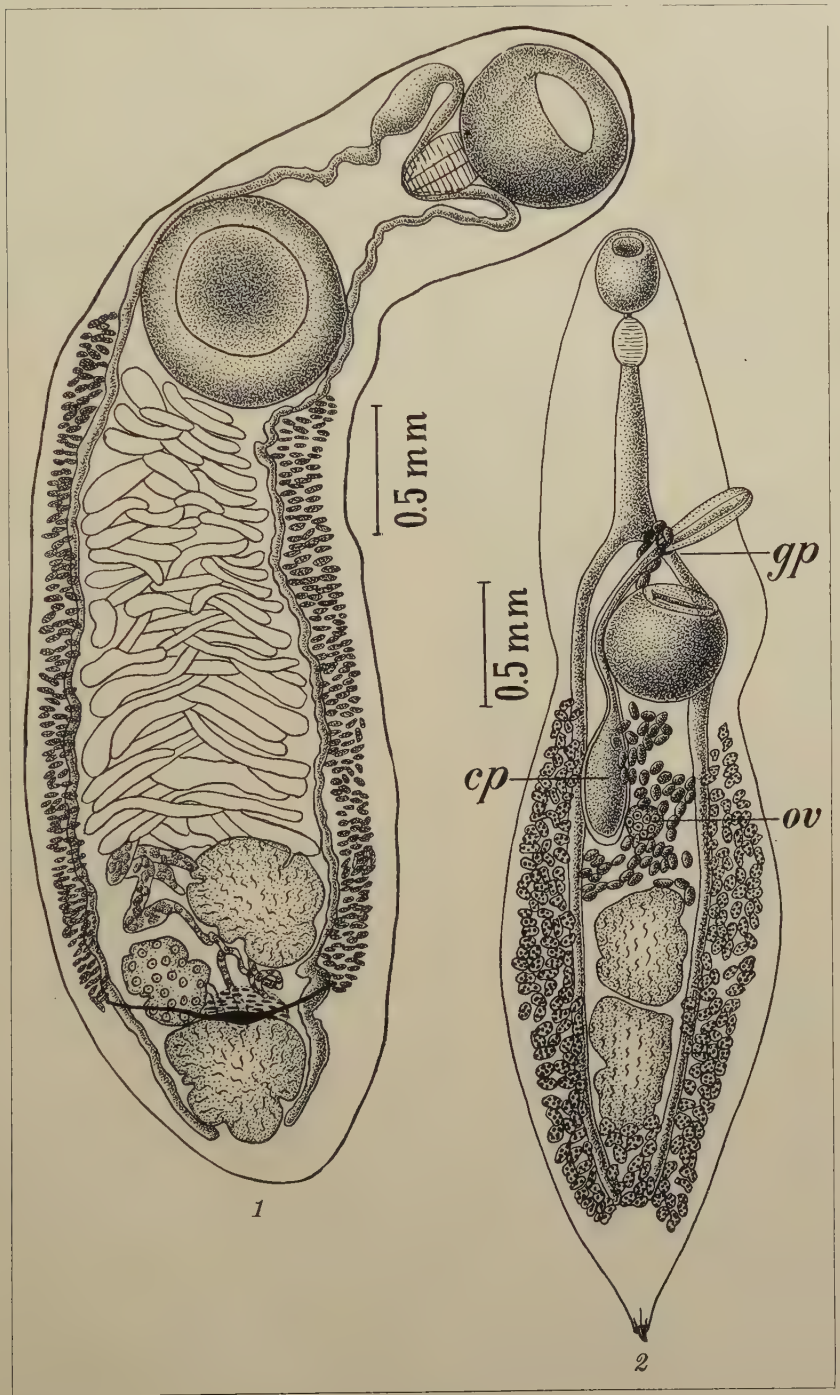

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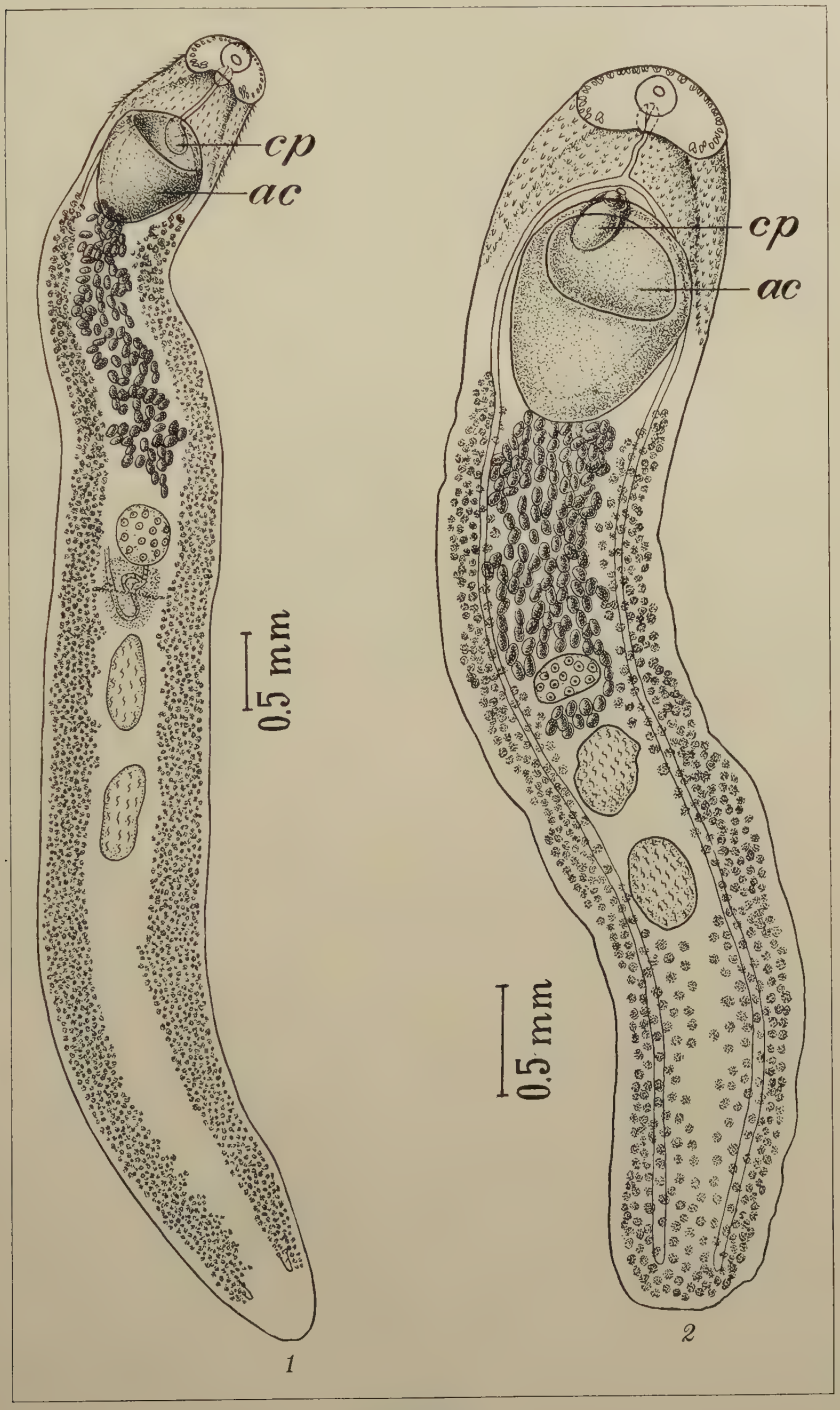

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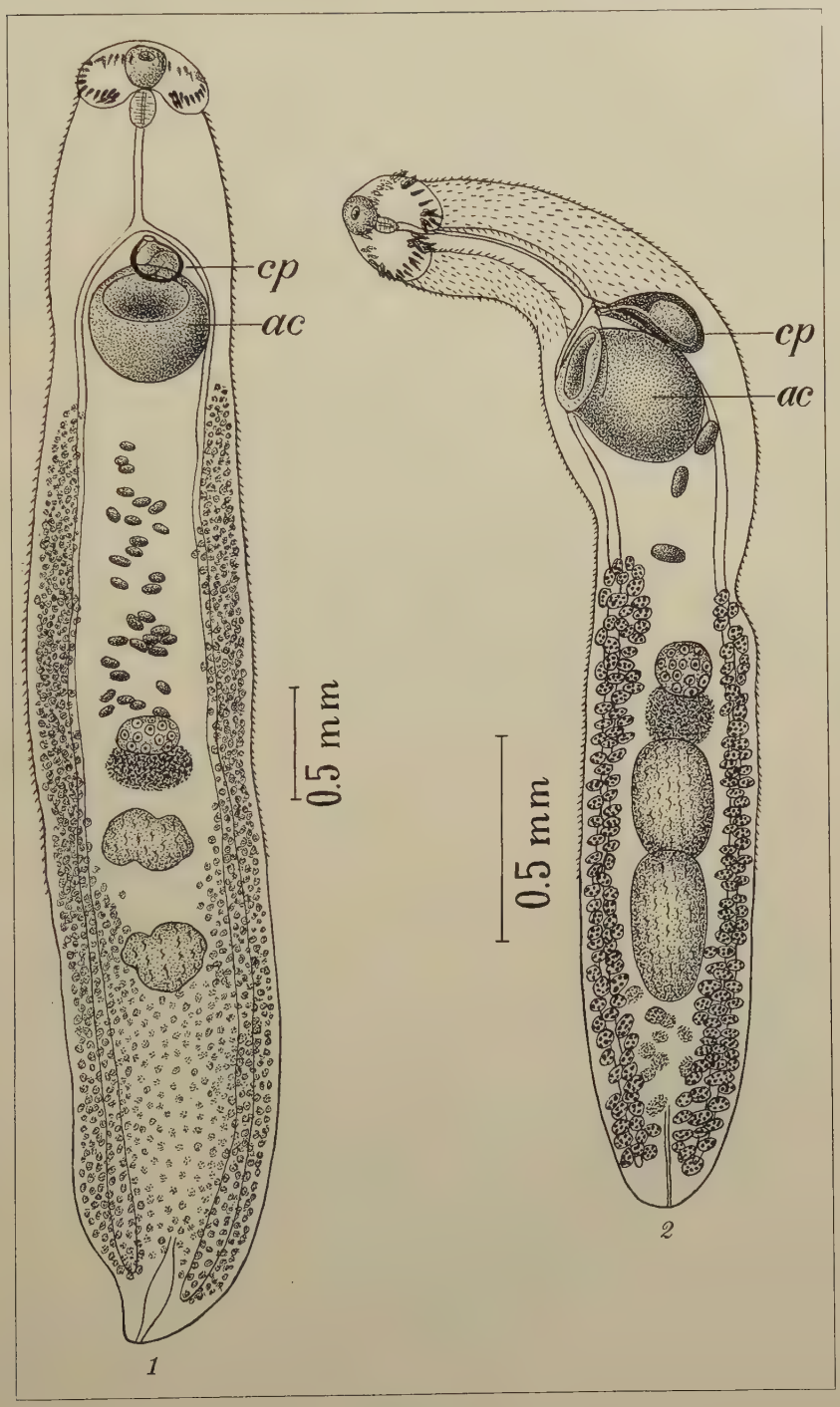

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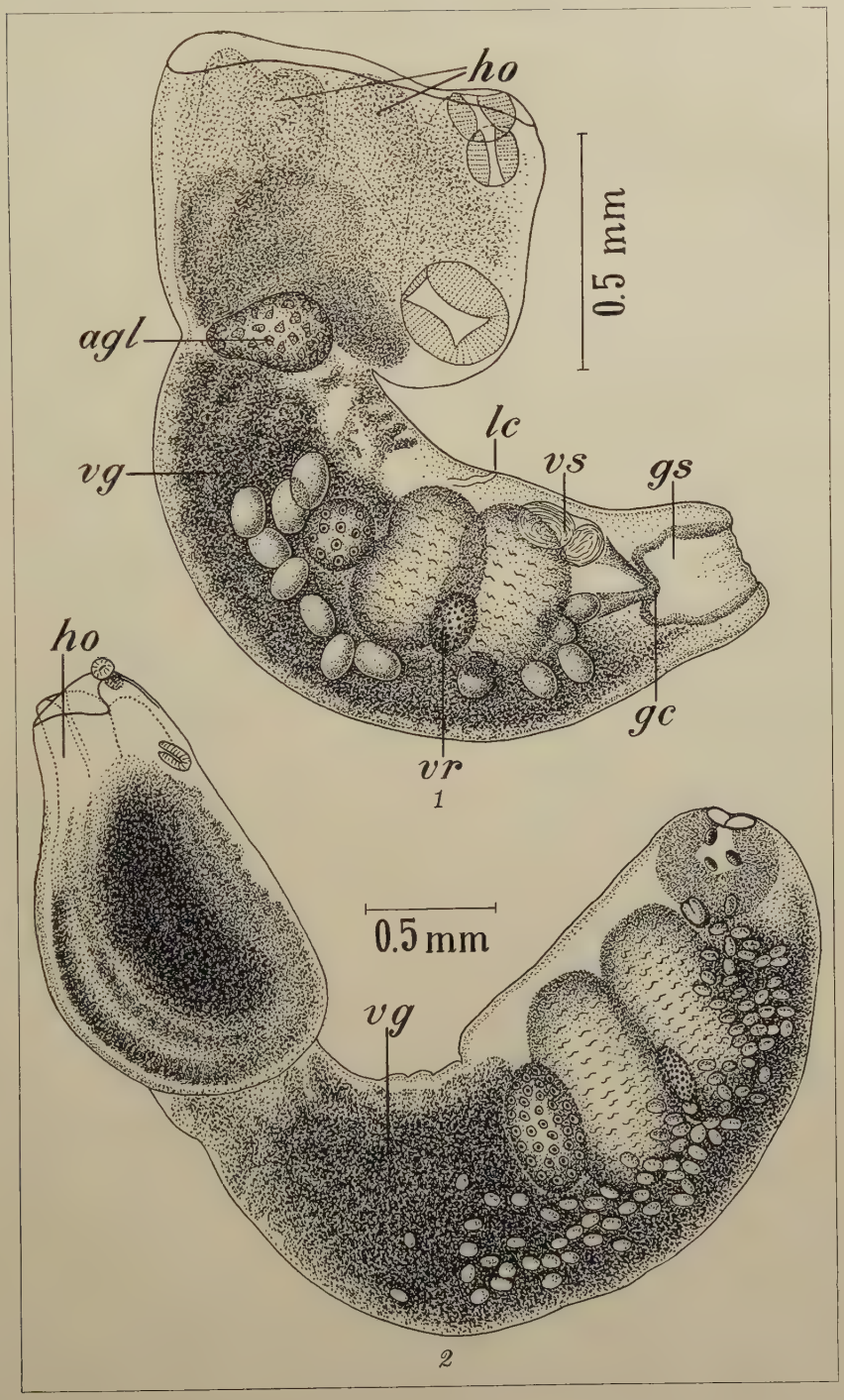

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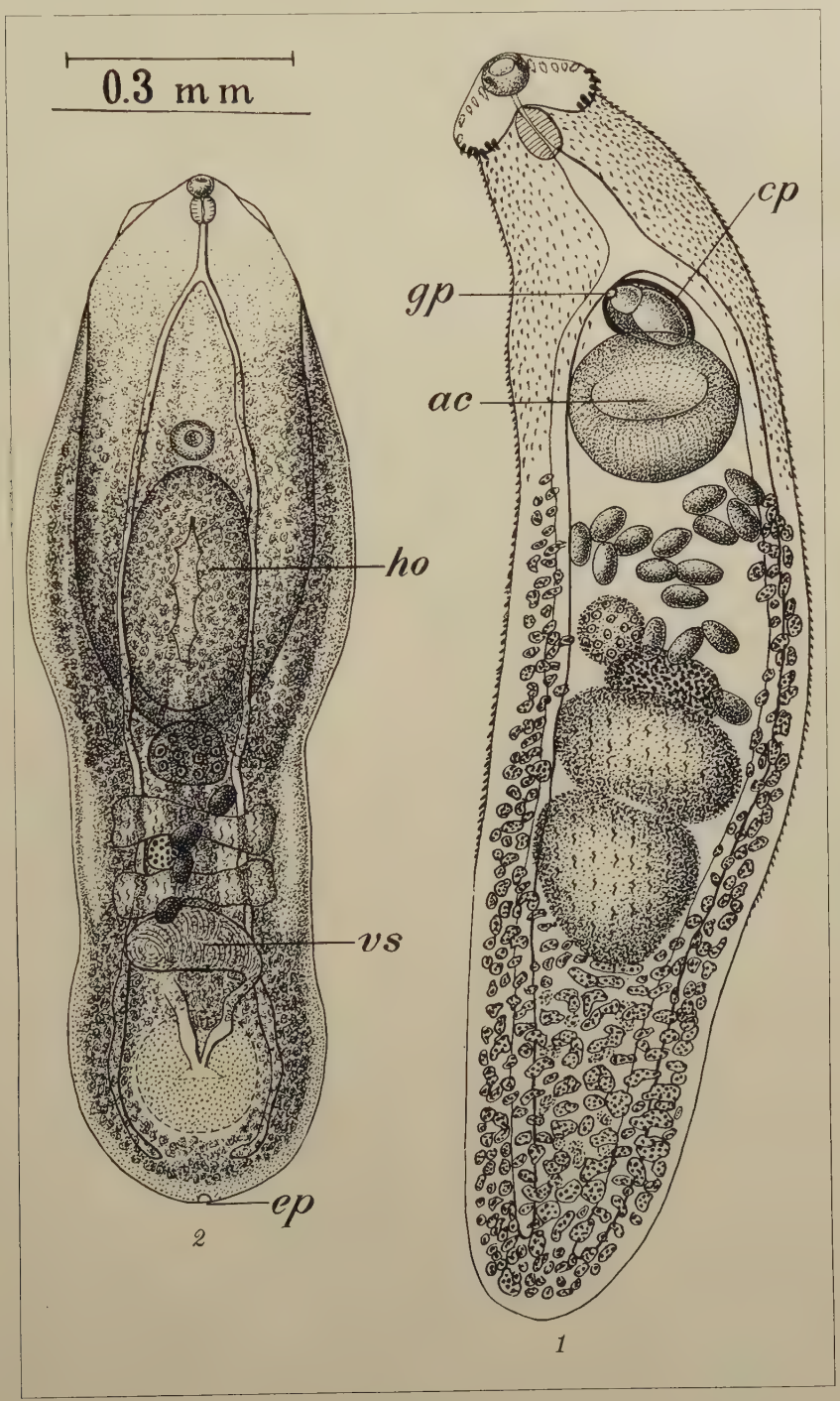

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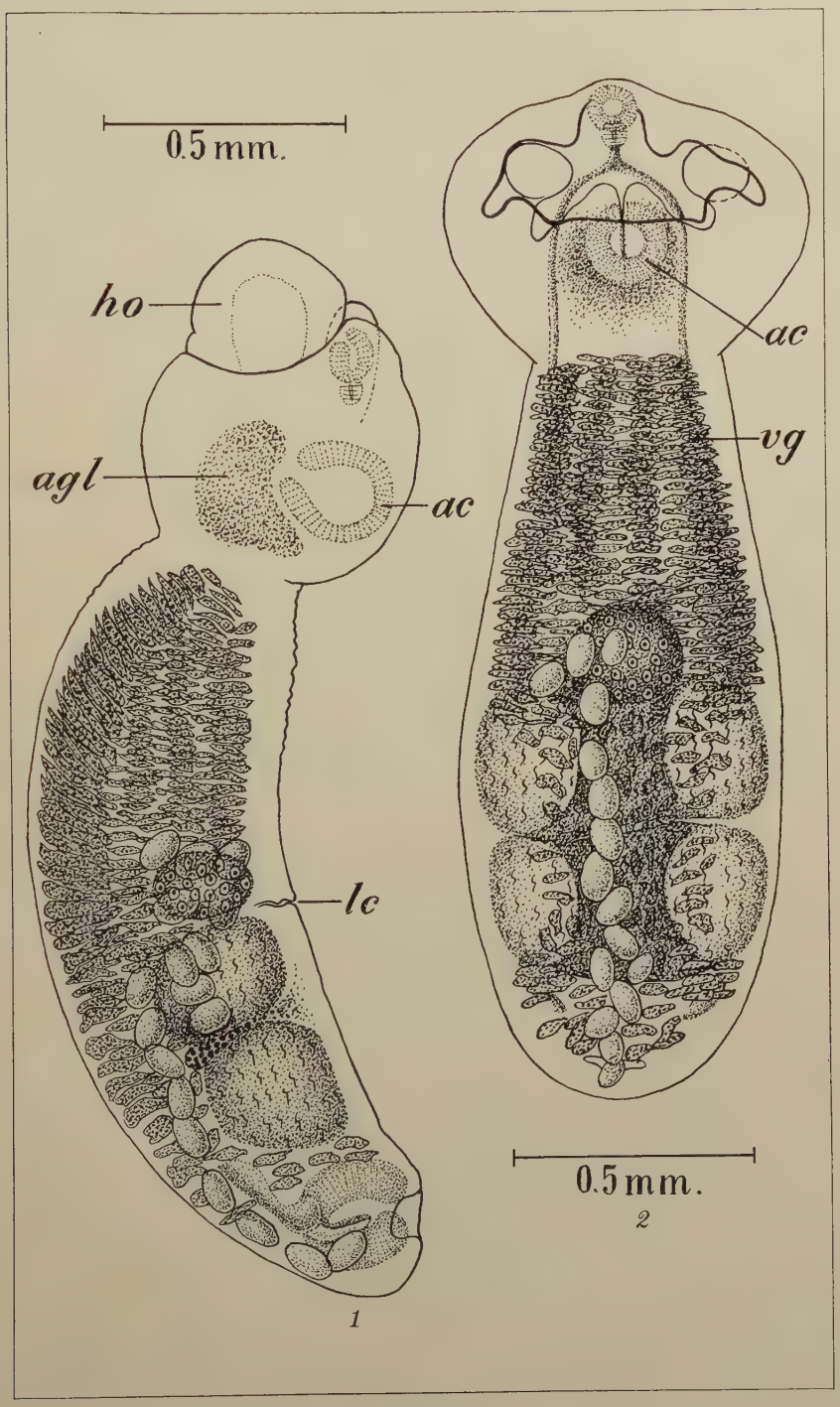

PLATE 10.

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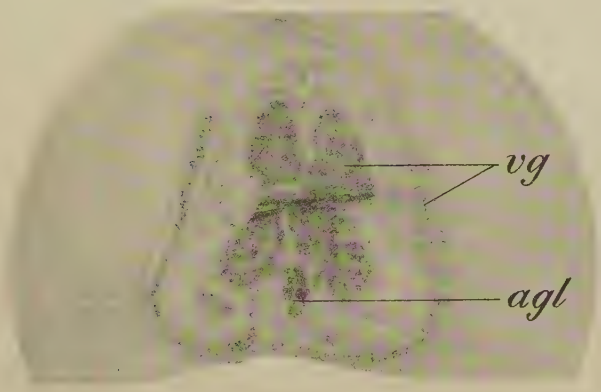

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PLATE 11.

FISHING METHODS IN MANILA BAY

By Vicente C. Aldaba

Of the Bureau of Science, Manila

FIVE PLATES AND SEVEN TEXT FIGURES

The rapid growth of the fishing population in the towns around Manila Bay has driven many fishermen to other Philippine coastal regions where there is less competition. Many fishermen from Naic have transferred their activities to Ragay Gulf, and a fishing village on the shore of San Miguel Bay is made up almost entirely of fishermen from Malabon. In many other places in the Philippines fishermen from Manila Bay are introducing their own methods of fishing.

Home seekers migrate to even a greater extent than do the fishermen. These settlers seek favorable locations along the coasts and rivers where natural transportation is available. If trained fishermen are among the settlers their struggle is made easier as they are taught new means of acquiring animal food, but, unfortunately, many communities are totally ignorant of fishing methods. This paper is prepared with the idea that it may be of help to such settlers.

SIMPLEST METHOD OF FISHING

The simplest method of fishing must be that in which the bare hands without apparatus are employed. Along the beach and in shallow rivers about Manila Bay, men, women, and children may be seen feeling for and catching fish with their hands under the water. Shrimps of various kinds, crabs, particularly the *alimasag* (*Neptunus pelagicus* Linnæus) and even *kanduli* (*Arius* spp.) are caught in this way. More enterprising fishermen inclose portions of rivers and ponds with mud embankments and then bail out the water with the help of pails or kerosene cans.

SPECIALIZED METHODS OF CAPTURING DIFFERENT KINDS OF FISHES

The difficulty encountered in capturing fish with the bare hands made it necessary for fishermen to think of easier and better ways. In doing this they were naturally guided by the

habits of the different kinds of fishes with which they had come in contact. Thus, methods adapted only for certain kinds of fishes have been developed.

The pangigat (*fig. 1*).—In many places around Manila Bay, especially in newly drained fishponds and muddy surfaces between tidal zones people may be seen at times dissecting the

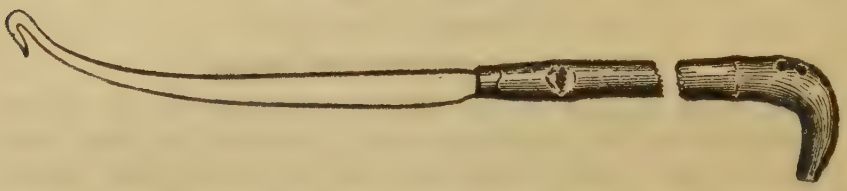


FIG. 1. Pangigat.

mud with an instrument called *pangigat*, a name derived from a certain kind of eel, the *igat* (*Synbranchus bengalensis* McClelland), which it is designed to catch. This fishing instrument is about 1.5 meters long and consists of two parts; namely, a handle of bamboo about a meter in length, and an iron rod with a hook at the end. When this instrument is driven into the mud and pulled out obliquely it hooks any igat that may be in the way. Usually the fisherman locates the hole of an igat before using the apparatus.

The pamalos (*fig. 2*).—To catch the large species of eel known as *palos* (Anguillidæ), the *pamalos*, a kind of spear with seven prongs, five pointing downward and two upward, is used.

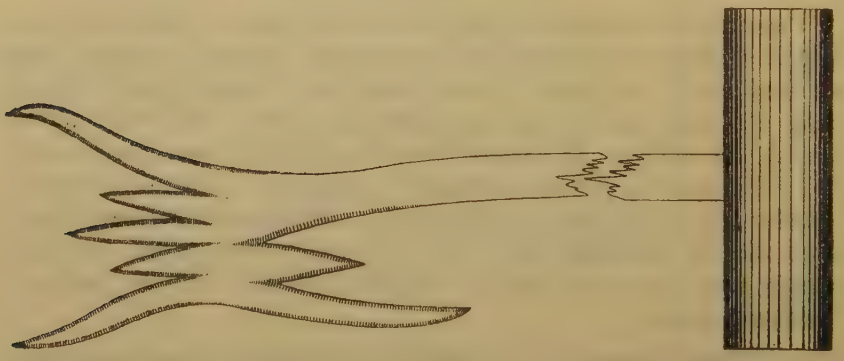


FIG. 2. Pamalos.

The habit of the palos is to retreat into a hole in the mud, and an experienced fisherman knows from its appearance whether or not a certain hole contains an eel. He drives his spear

deep into the mud around the hole, repeating this performance until he strikes the palos, of which he immediately becomes aware by a certain feeling, which he has learned to know from experience. The palos on being struck coils about the spear and is caught by the upper prongs. The fisherman then pulls out the spear with the catch.

In shallow rivers and along the coast of Manila Bay, in Bulacan, Pampanga, and Bataan Provinces, a kind of crab much valued as food, known as *alimañgo* (*Scylla serrata* Forskål), is caught in large numbers. There are several ways to catch this particular kind of crab.

The panukot.—The habit of the alimañgo is to make and hide in more or less horizontal holes. This has given rise to the use of the *panukot,* an instrument made up essentially of a bamboo pole and an iron rod, the latter bent so as to form an L, the upright leg of which is attached to and forms an extension of the bamboo pole (fig. 3). The length of the whole device depends upon the depth of the crab holes. A metallic sound is

FIG 3. Panukot.

produced when the iron hits the hard coat of the crab, thus revealing its presence. By constant irritation it is made to hold tenaciously to the iron with its claws. The fisherman then throws the crab on its back by turning the pole over and pulls his catch out of the hole.

The tapañgan.—In Bulacan a trap known as *tapañgan* is used extensively to capture crabs. This device is cylindrical in general appearance, about 50 to 60 centimeters long, and about 20 centimeters in diameter. The cylinder is very slightly tapering toward each end. It is made of split bamboo tied in parallel order to four almost equidistant hoops whose diameters determine those of the trap. At each end of the cylinder is a funnel formed by pointed bamboo splints held together usually by rattan so that the pieces that converge inwardly into one point are free. Thus the crab can enter easily but cannot go out (Plate 1, fig. 1). The bait, which consists of dead fish or small living crabs, is contained in a small bamboo tube placed inside the trap. A number of these traps are set in shallow rivers and in nipa and mangrove swamps where they are covered

with water during high tide. A fisherman may have as many as forty or more set at one time.

The bintol.—Another effective trap for crab is the *bintol.* This consists of two pieces of bamboo each about 60 centimeters long set across each other perpendicularly, and a square net whose four corners are attached to the four ends of the two bamboo pieces. Because the diagonals of the net are shorter than the bamboo pieces, the latter are bent and the net is stretched; the whole affair forming a structure that is more or less rigid. The bamboo pieces are about 50 centimeters long and 2 centimeters wide, and carry lead or burned-clay weights at the ends. Hanging from the crossed bamboo pieces is a small bamboo tube that holds the bait. A float, of bamboo or wood, shows the location of the trap (Plate 1, fig. 3).

The crab in order to reach the bait uses its claws through the small holes of the bamboo container. When the trap is brought out of the water the crab ceases to struggle for the bait and tries to escape by letting itself fall. It is then caught on the net. A person fishing for crabs with bintol may set as many as a hundred at a time in rivers, estuaries, and along the seashore. He probably will visit them several times during the day if crabs are plentiful. He uses a pole with a hook at one end to lift the bintol out of the water, catching the string below the float.

The panti.—The *panti* is a larger affair and although it catches alimañgo it is really intended for alimasag. It is about a meter wide and varies in length from a few to 200 meters or more. Its lower side is weighted with iron-wire rings about 10 centimeters in diameter. There are no floats except a piece of bamboo at each end. The net is not, therefore, rigidly stretched vertically. The crabs swim close to the bottom and on striking the net become entangled and caught. This method of fishing is especially common in Puerto Rivas, Bataan Province, where there is a long stretch of gradually inclined seashore.

The tigpao.—A very simple but effective method of catching alimasag but one that calls for great skill is the *tigpao.* This is a dip net made of fine wire or cotton twine having a circular opening about 40 centimeters in diameter and being attached to a pole about 3 meters long. On the other end of the pole is a paddle. The fisherman stands at the bow of his banca paddling, at the same time scanning the water for flashes of light that betray the presence of crabs after dark. He swiftly uses

the dip net on the other end of the pole and takes the crab into the banca. Naturally this kind of fishing is done only during dark nights.

Probably the best-known and most commonly eaten crustaceans around Manila Bay are the various kinds of shrimps. Methods for capturing them are highly developed.

The sakag.—The commonest way of catching shrimps is with the use of a *sakag* (Plate 2, fig. 1). The net of the sakag varies in size of mesh depending on the kind of shrimps to be caught. For *alamang* (small shrimps) a sakag with *sinamay* netting is used. For larger kinds of shrimps, nets of varying mesh are used. The fisherman uses a light placed on his head to attract the shrimps.

The diacus.—The *diacus* is a bag net placed at the mouth of rivers that contain plenty of alamang. The bag is made of sinamay and may be 20 meters deep and 10 meters wide with the pocket gradually tapering towards the rear. The vertical dimension of the mouth depends on the depth of the river.

The bintol.—In Naic, Cavite Province, fishermen use a kind of bintol for alamang. The bamboo pieces are about 1.80 meters long and the net, which is made of sinamay, is about 1.10 meters square. A float of bamboo is used (Plate 1, fig. 3).

The apparatus is placed in river beds. There is no bait of any kind and why the alamang stay in the net is not readily explained. In former days dried banana leaves were placed inside the bintol. The idea was to provide a sort of playground or home for the alamang, but it was discovered that the leaves could be dispensed with.

The kimpot.—In the upper part of the Pampanga river the people use a trap that they call *kimpot* for catching shrimps. This is similar to the tapañgan in form. There is, however, only one funnel; the other end tapers to a narrow opening provided with a stopper. The catch is drawn out of this opening. It is baited with roasted tikitiki in balls, corn, or peelings of grapefruit. According to the fishermen, the bait serves to attract the shrimps (Plate 2, fig. 2).

The lawiswis.—An interesting apparatus for catching shrimps is known in Bulacan as *lawiswis* and in Pampanga as *kalaskas.* It is essentially a narrow banca about 7 or 8 meters long with a sort of platform made of bamboo slats a little shorter than the banca itself, and about 50 centimeters wide firmly attached to one side. To balance this structure, larger bamboos, usually

two or three, are attached to the other side of the banca. In Pampanga pieces of *palma brava* (*Livistona* sp.) are more often used. A bamboo pole to which are firmly attached on one side a number of small tapering bamboo splints forms the lawiswis or kalaskas, the name adopted for the whole apparatus. The splints vary gradually from 0.5 to about 1 meter long towards the bow. The lawiswis is held by a vertical wooden pin at one end of the banca. It can, therefore, move only in two directions. (The splints are on the same side of the banca as that to which the platform is attached.)

The fisherman chooses for his fishing ground a sandy bottom with water about knee deep. He then grasps the end of the banca with one hand, the pole with the other and tips the banca to one side so that the ends of the splints touch the bottom. He pushes it with some speed, the splints whipping the water as the banca is pushed along. The shrimps jump on being disturbed and many of them land in the banca (Plate 3).

The pangugnat.—In Bulacan and in Bataan a species of goby known in these localities as *ugnat* (*Oxyurichthys microlepis* Bleeker) is captured almost exclusively by a unique method in which dried banana leaves and a stationary sakag play the main rôle. Two men operate this fishing apparatus, called *pangugnat,* one handles the sakag, and the other manipulates a line 100 meters long, usually made of *cabo negro* [fiber of a palm, *Arenga pinnata* (Wurmb) Merrill] to which dried banana leaves are attached in a parallel manner. The line is weighted usually with burnt clay, lead not being much favored because of its tendency to sink in the mud.

Fishing is carried on near the seashore where the water is about breast-deep. The man who handles the sakag stands stationary. By his side is a stake to which is tied one end of the line. The man holding the other end of the line describes an arc with the stake as center and the line as radius. At about the end of his trip he approaches the sakag, gradually shortening the line as he does so. The whole operation of the line has for its object the driving into the sakag of the gobies that happen to be in the area included within the section described by the operator. The sakag is then lifted out of the water and the fish collected. The fishermen then move to another place.

The katigbi.—The *katigbi* is operated in a somewhat similar manner to the preceding apparatus but it catches mainly *aligasin* (Mugilidæ). In place of the sakag is a bag net and instead of the line with banana leaves is one carrying thin pieces

of coconut husks. Ordinarily the line is about 50 meters long. It carries no weight and, therefore, stays on the surface of the water. Two men hold the net in position and another two manipulate the line, each holding one end. Starting from a distance the linemen approach the bag with as much speed as

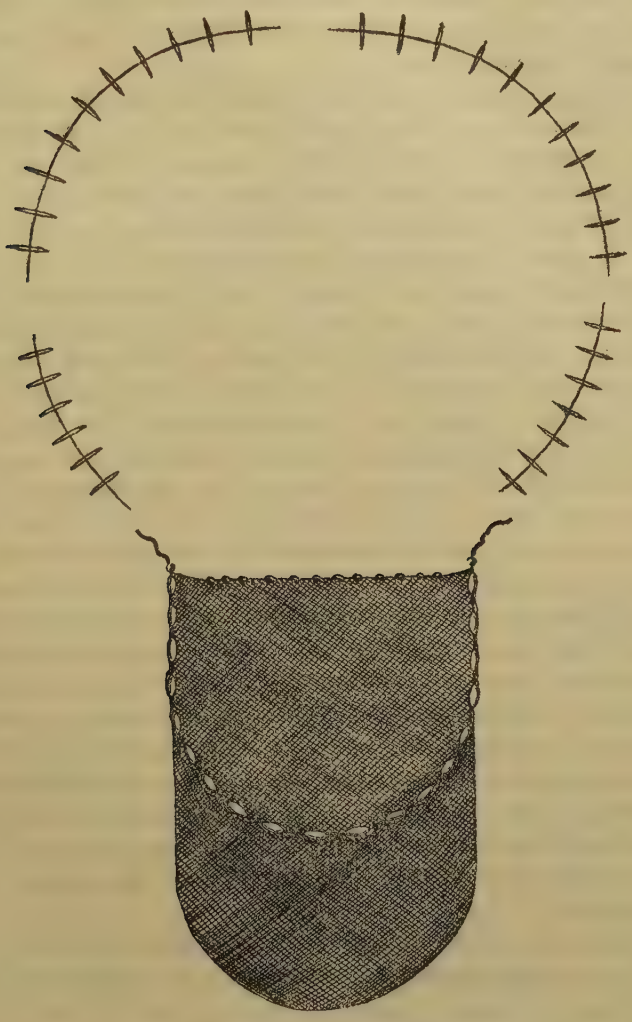


FIG. 4. Katigbi.

they can make in the water. As soon as the bag is reached, they shorten the line hurriedly. The men holding the net then lift the lead line so that the entire opening is above the water. The catch is collected after the bag is hauled into the banca. Another place is then selected for the next operation (fig. 4).

The gill nets.—Pelagic fishes, especially those that go in schools, are readily caught in large quantities in gill nets. This fishing gear is essentially a net with a mesh large enough for the fish to push its head through but not the body. When the fish backs out, the net becomes caught between the gill-cover and the shoulder bone. The fish is then said to be "gilled." Naturally, the mesh of a gill net is of the size that would gill the species for which it is intended.

The bating.—There are several kinds of gill nets in common use in Manila Bay. The most important is the *bating* for catching herrings of which there are a number of species; namely, *tunsoy* (*Harengula moluccensis* Bleeker), *tamban* (*Harengula longiceps* Cuvier and Valenciennes), etc. The net has a mesh of about 2.8 centimeters stretched and is usually about 720 meters long but may extend to 1,000 meters and is about 15 to 20 meters deep. A complete outfit would represent an investment of from 5,000 to 7,000 pesos, including a large banca, and requires for its operation from twenty to thirty people. The banca is usually towed by a launch around the bay, until a school of sardines is located when the banca is loosed. The net is then laid out to surround the school, and the sardines are driven to the net by people who beat the water with special poles carrying a club and noise-making device at one end. The operation is usually in the daytime and it is quite a sight to see a number of fully manned bancas carrying bating as they are towed by their respective launches around a place where sardines have just been caught. In each banca there is a watch tower, which consists of a strong bamboo pole. A school of sardines is readily located at a distance if the weather is clear, on account of the up-and-down movements of the sardines. If a bating has made a catch it is an indication that there are many other schools near-by since all of these are really parts of a larger school. Hence, the flocking of the bancas around the one place.

In Manila Bay alone there are about eighty of this type of fishing gear, representing an investment of nearly half a million pesos.

The panglambang.—The *panglambang* is similar to the bating except that there are two bancas, each carrying a net and moving toward each other in order to inclose a school. It requires, therefore, more men and usually more capital.

The largarete.—The *largarete* is much smaller than the bating, consisting of a net only 20 meters long and 15 to 20 meters deep. It is placed parallel to the banca, each end attached to one of two bamboo poles that are projected from the bow and stern of the banca. At night light is used to attract the fish.

The kansisi.—The *kansisi* is still smaller than the largarete and is used to gill herrings.

The patibog.—The *patibog* is a gill net for different species of aligasin. It is operated in the daytime, and once the school is encircled the fish are driven into the net by beating the water as in the bating.

Other gill nets.—There are gill nets for other kinds of fishes and one with a large mesh about 10 centimeters stretched is used for *tanguingue* (*Scomberomorus commersoni* Lacépède). The *pangjoya* is a small affair to catch bottom fishes, mainly the slipmouth (*Leiognathus* spp.). It is only 1 to 2 meters deep and 50 to 60 meters long. The weights are heavy enough to take the whole net to the bottom of the sea, the float being of sufficient buoyancy to keep the net vertical. An interesting net, although not common, is the one for gar, or needle fishes (Belonidæ). It carries a float but no weight, and the fish are caught by entangling their beaks in the net.

METHODS FOR CATCHING FISHES IN GENERAL

The most important kind of fishing apparatus in Manila Bay is the fish corral, locally known as *baclad.* The availability of bamboo, which is the most important material that goes into the making of a fish corral, must have had a great deal of influence on its development. The other important fishing apparatus that are made of bamboo are the *bobos* of which there are many shapes and sizes (Plate 2, fig. 3, and Plate 4). The nets of different kinds come next to fish corrals in importance.

There are two main types of fish corrals; namely, one with two wings and the other with a leader. Where the current is likely to be strong and shrimps are abundant the former type is the one usually constructed. In the open sea where there is hardly any current and where fish are more plentiful, a baclad with a leader, a heart, and two pounds is usually found. There are various modifications and combinations of these two types.

The bakikong.—The *bakikong* is the smallest fish corral to be found in regions around Manila Bay and consists of only a

small heart with a woven-bamboo bottom. It is about 0.5 meter in diameter and 1 meter high, with two very short wings, less than 0.5 meter long. This is placed before an opening in the dam of a rice paddy that is being drained of excess water.

Some rice paddies around Manila Bay are under water at high tide during June and July. Here shrimps are caught in quantities with the bakikong during August and September.

The palapad.—Those engaged in fishing with this apparatus choose a level or slightly inclined sea bottom that is under water at high tide and almost entirely exposed at low tide. This kind of place is usually found near the seashore. When the water has about reached its highest mark the fisherman incloses an area more or less semicircular, about 200 meters or more in radius, although many times it is less than this. When the water is low the fish are collected and another place is located for the next coming of the tide.

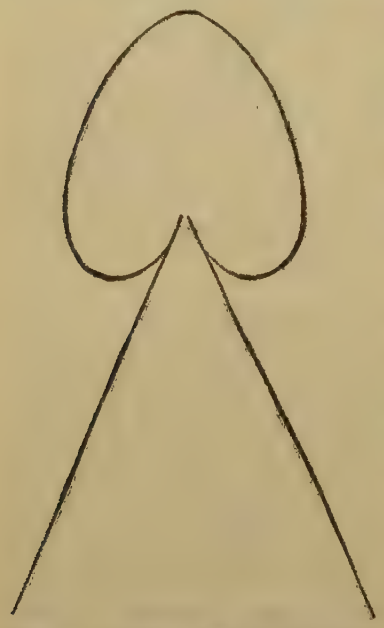


FIG. 5. Diagram to show the construction of a bunuhan.

The bunuhan.—The *bunuhan* is found in rivers where a strong current is produced by the receding tide in the bay. It varies in dimensions depending on the depth and width of the river. The wings, especially, are likely to be long. It catches many shrimps, but may catch any fish that happens to be carried by the current into the pound (fig. 5). The heart is complete in itself with a woven-bamboo bottom.

The abang.—The *abang* is similar to the bunuhan, but is a larger affair and is used in deeper rivers.

The sinipete.—The *sinipete* has also two long wings but has two or three pounds, the first leading into the second and the second into the third.

The aguila.—The general type of baclad in Manila Bay is that with a leader. In shallow waters near the seashore, especially, the leader is placed at right angles to the shore. At the end of the leader away from the shore is a more or less semi-

circular inclosure, the heart, the center of which lies somewhere in the leader. At each end of the semicircumference there are usually two pounds, one leading into the other (fig. 6). This type of baclad is known locally as *aguila* (a mythical double-headed bird) or *ancla* (anchor).

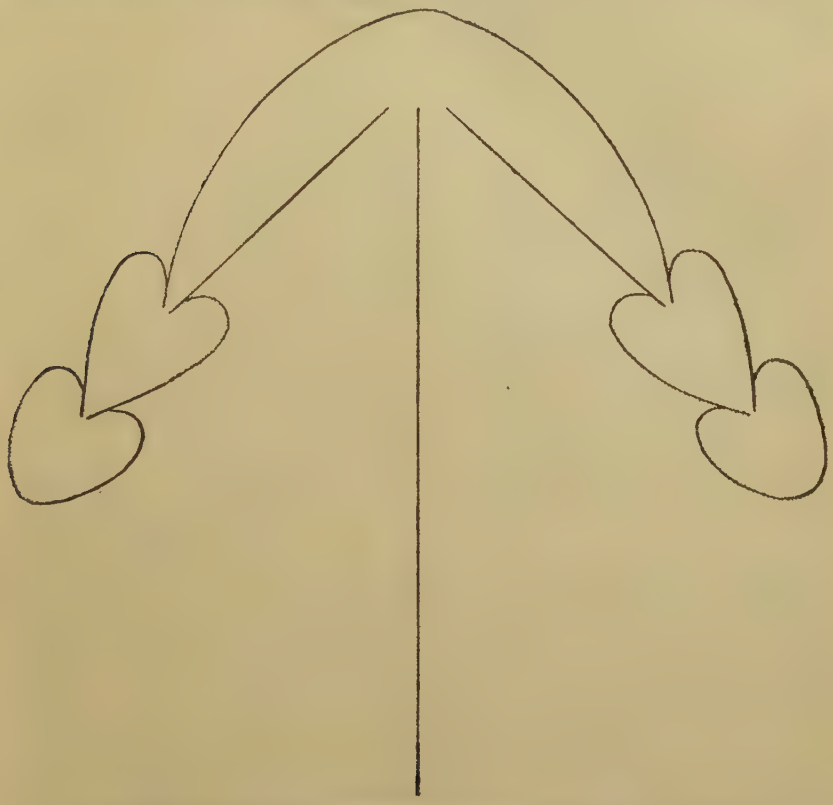


FIG. 6. Diagram to show the construction of a fish corral of the aguila type.

Along the shore of Bulacan, which slopes gradually into the sea so that for a long distance from the beach the water is shallow, the aguila is the type most commonly met with. The baclad is low and is, therefore, not so expensive, costing from 80 to 250 pesos. A small dip net is used to collect the fish from the pound.

The linea.—In Navotas, Salinas, and Orion where the shore declines more rapidly, so that there is deep water at a convenient distance from the shore, deep-water corrals (*lineas*) have been developed more than anywhere else in the bay. The

deep-water corral differs in form from that of the shallow-water aguila in that only one end of the heart is provided with one or two pounds. The fish are collected with a net requiring from seven to fifteen men to manipulate. The baclad is expensive and may cost from 2,000 to 4,000 pesos. Some baclad may be used in water 15 meters deep (fig. 7).

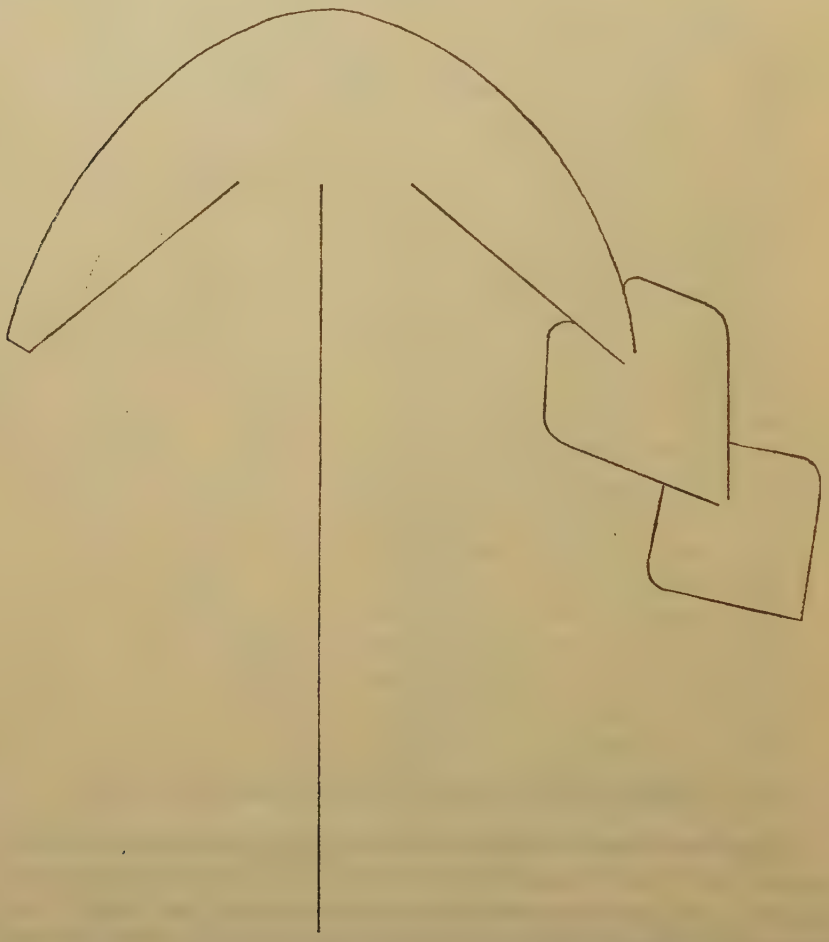


FIG. 7. Diagram to show the construction of a deep-water fish corral.

The ordinary bobo.—The commonest and easily the most important *bobo* to be met with in Manila Bay is the one shown in Plate 2, fig. 3. It is provided with one funnel and is what is usually referred to when bobo is spoken of. This is a very important fishing apparatus in Orion, Bataan, and in Naic and

Salinas, Cavite. In Bulacan it is also quite important, but in Pampanga it is seldom used. The bobo used in shallow water is comparatively smaller and is baited with alga. Usually it catches *samaral* (*Teuthis* spp.). In Salinas and Naic the bobos are larger and are intended for deep water. They then catch groupers mainly. A fisherman may have as many as 200 bobos placed at the bottom of the sea in different places. He visits about 15 to 16 every day so that a bobo is visited about once every two weeks.

The locating of these bobos in deep water is quite a problem and requires a good deal of experience. No markers of any kind should be left on the surface of the water to indicate the location of a bobo since other people may take the fish and even the bobo itself while the owner is absent. Before dropping a bobo in a place, the intersection of two lines made by landmarks at a distance, usually the peaks of mountains or church towers, is determined. The bobo is weighted so that it stays at the bottom and to it is attached a cabo-negro rope about 5 meters or more in length with a weight at the loose end. To bring a bobo to the surface of the water the fisherman uses an iron hook which he drags along the bottom until he catches the rope attached to the bobo.

The sullang.—In deep-sea baclad there is sometimes placed inside the pound a kind of bobo known in Bataan as *sullang*. This is placed in the water with the funnel up and is supposed to catch fish that dive straight from the surface to the bottom (Plate 4). In Salinas only the owner can put a sullang in the corral, while in Orion it is a privilege given by the owner of the baclad to the men who are working with him.

The bonbon.—As the name *bonbon* implies, this is a pile of branches and twigs in shallow water. The idea is to provide a sort of playground and home for different kinds of fishes. In order that the materials be not carried away by water the branches are stuck into the mud. After a certain time, usually about two weeks, the pile is inclosed in a baclad and the branches and twigs are taken out. The fish are then caught by narrowing the inclosure gradually. A dip net is used to take the fish out if the water is of considerable depth.

The salakab.—Strictly speaking this fishing gear is for freshwater fishes, such as those that are collectively known as mudfishes, and is therefore properly treated in detail in a paper on fishing methods in Laguna Bay. But in Manila Bay, in small

shallow rivers, and in fishponds that are being drained the *salakab* is a very handy fishing gear to catch fish with in shallow water. The usual size varies from 25 to 50 centimeters in diameter and from 50 to 100 centimeters in height.

Hook and line.—The hook and line is probably the cheapest and most easily obtained fishing gear in regions around Manila Bay. Any boy can have a fishing rod most anywhere merely by securing a small branch of bamboo. With a short string, an ordinary bent pin for a hook, and some small shrimps or sandworms for bait and he is ready to go fishing. Ordinary fish hooks are of course procurable in the stores, though many fishermen prefer to make their own hooks. Fishermen from Naic and Orion use a trolling line known as *sibid-sibid,* the hook of which is baited with white chicken feathers tied around a small bamboo ring. Fishing is done in a fast sailing banca so that as the line is dragged along the water the feathered ring revolves continuously. The turning feather is supposed to attract the fish. Tanguingue is usually caught.

The kitang.—This is a line about 200 meters long, to which are attached about a meter apart many short lines or snoods each carrying a hook. Usually from 100 to 200 hooks are used. The line is placed stationary at the bottom of the sea with a float to indicate its position. This kind of trawl-line fishing is found in Cavite, Bataan, and Bulacan mainly.

In Bataan the pangugnat and the *kitang* form a fishing unit. The former serves to catch enough gobies to serve as bait for the latter.

The seine.—The seine is among the oldest nets known in the world and consists essentially of a long narrow strip of net with the necessary floats and weights to maintain the upper part of the net at the surface of the water and the lower in close contact with the bottom of the sea. It is usually employed to catch fish on a gradually inclined seashore.

The net is composed of three parts; namely, the two wings and the bunt between them, the latter having a smaller mesh than the former. Throughout the whole length the net may be of uniform depth or narrower at the wings and deeper at the bunt so as to form a pocket or purse. Into this pocket all the fish inclosed by the seine are impounded as the net is being gradually hauled to the shore out of the water. For

anchovies, dilis (Engraulidæ) and young herrings, *siliñasi* (Clupeidæ) the seine may be made of sinamay.

The talacop.—The *talacop* is a purse seine for catching *hasá-hasá* (*Rastrelliger brachysomus* Bleeker) and *alumahan* (*R. chrysozonus* Rüppell). This in principle is different from an ordinary seine in that instead of having a pocket and distinct wings and being operated on a gradually inclined seashore, it is operated in deep water and the whole net is manipulated so as to form a sort of pocket by "pursing" the lead line, thus preventing the escape of the fish through the bottom. Their escape on the surface is made impossible by the head line kept at the surface by the floats. In order that the "pursing" may be easily accomplished rings are placed along the bottom line through which passes a rope that is pulled hurriedly as soon as the school is completely surrounded by the net. Thus, before the fish are able to make their escape the bottom is closed. The net is then hauled in until all the fish are confined to a small area. They are then taken out with a dip net. Many fish are also gilled. This net is about the same in dimensions as the bating. Another, and older, name for the talacop is *cubcub.*

The prawn net.—This is a modification of the seine, but the pocket is much deeper and it is used under water. The weights are proportionately heavier than the buoyancy of the floats, the latter holding the net in a vertical position with the pocket opened. The nets in Manila Bay that would be included under this classification are the *pukot* or *hila-hila,* and the *taksay.* The pukot, or hila-hila, is used in shallow rivers emptying into Manila Bay and where shrimps are caught in large quantities. It is especially common in Tinajeros, a barrio of Bacolor, Pampanga. The pocket is usually about 10 meters long with a mouth 4.5 meters in breadth and a wing on each side of about 2.5 meters or a little less. The depth of the net is 2.5 meters. The mesh is 2.5 centimeters stretched at the mouth, and 1.75 centimeters at the back of the pocket. The end of the pocket has an opening about 0.75 centimeter in diameter, and this is tied to close the pocket when in operation.

Two men are required to operate this gear. It is started from one side of the river and pulled across at an angle to the course of the water, each man pulling a rope holding one end of the gear.

The saklit.—The *saklit* is a small pukot and is operated in small streams. It is about one-half the pukot in all dimensions and no rope is necessary to operate it. The mesh is about 1.5 centimeters stretched at the back of the pocket and about 2 centimeters at the mouth.

The taksay.—The *taksay* is operated in the deeper parts of Manila Bay, and the operators therefore are in a banca. The net is dropped to the bottom and by means of tow ropes at each end, which may be 100 meters long, it is dragged along the bottom of the sea by pulling the ropes into the banca until the net is brought in and the catch collected. Then the net is again thrown into the water and allowed to sink to the bottom, when the operation is repeated.

This net usually has a pocket about 4 meters long and the mouth and wings have about a 20-meter spread. The lower part of the net is usually of hemp. The mesh is about 4 centimeters stretched. Six men usually operate this net from a 12-meter outrigger banca.

The utase.—A similar apparatus operated in Manila Bay, but larger, is the Japanese trawl net, the *utase.* Instead of being dragged along the bottom of the sea by men in a banca, it is attached to a sailboat or launch. The net is dragged along the bottom of the sea for a long distance; that is, for the distance traveled by the boat during all the time of the operation. There are several utase outfits operated in Manila Bay by Japanese, supplying the market with a large quantity of bottom fishes such as *sapsap* (Leiognathidæ), *besugo* (*Nemipterus* spp.), and shrimps. Other species are also caught.

The biacus.—The *biacus* of Pampanga is similar to the diacus but is of fine-meshed cotton net instead of sinamay.

The salambao.—The *salambao* is in fact a bintol, but constructed on a much larger scale. It is suspended from the top of a tower, which may be as high as 15 to 20 meters and which may be moved so as to raise and lower the net in and out of the water in order that the catch may be taken with a dip net. The tower is operated by means of a weighted lever which the fisherman either pulls down or on which he climbs in order to bring up the end of the tower with the net. This gear is seen in most rivers and river mouths. Usually two men work together. It catches few fish at a time but is operated repeatedly every few minutes.

The pantukos.—The *pantukos* is for catching herrings. It is a large square or rectangular net with floats and weights to keep the upper line on the surface of the water and the lower line on the bottom. The corners are attached to ropes that are manipulated from two bancas on each side of the net. By means of noise and torches a number of men in fourteen or fifteen smaller bancas, formed in a line, start from the shore and drive the fish towards the pantukos. As soon as the fish are driven to the net, the sides are raised above the surface of the water, thus imprisoning the fish. The net is then pulled into the banca until the fish are confined in a small pocket from which they are removed by dip nets. This fishing gear was formerly common but is fast becoming obsolete.

The dala.—The *dala,* or casting net, is used most anywhere in the bay. This is a very old net that has been used in all parts of the world since time immemorial, and is therefore a gear well known to most fishermen. It is pyramidal in shape with a heavy string attached to the apex and the basal circumference heavily weighted. With one hand holding the string the fisherman casts the net into the water covering the school sighted. As the leads sink to the bottom, the fish are caught inside the net.

ILLUSTRATIONS

PLATE 1

FIG. 1. Tapañgan.
2. Bintol for crabs (*Scylla serrata*).
3. Bintol for alamang (small shrimps).

PLATE 2. SAKAG BEING DRIED.

PLATE 3

FIG. 1. Kimpot.
2. Bobo.

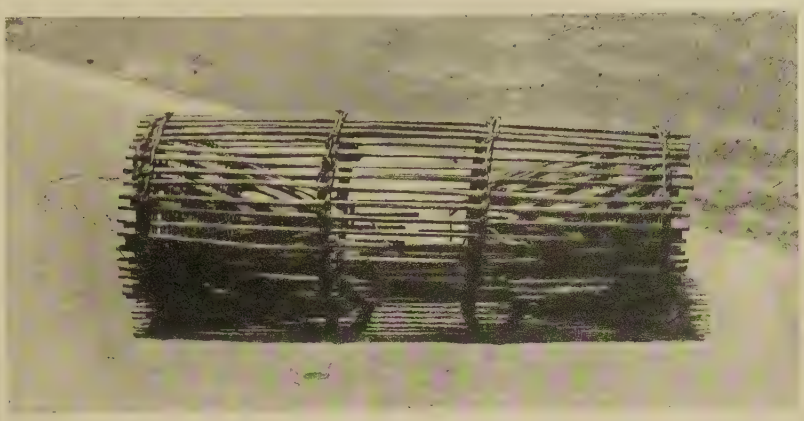
PLATE 4

FIG. 1. Lawiswis in operation.
2. Lawiswis; a close view of the back part to show details of construction.

PLATE 5. SULLANG.

TEXT FIGURES

FIG. 1. Pangigat.
2. Pamalos.
3. Panukot.
4. Katigbi.
5. Diagram to show the construction of a bunuhan.
6. Diagram to show the construction of a fish corral of the aguila type.
7. Diagram to show the construction of a deep-water fish corral.



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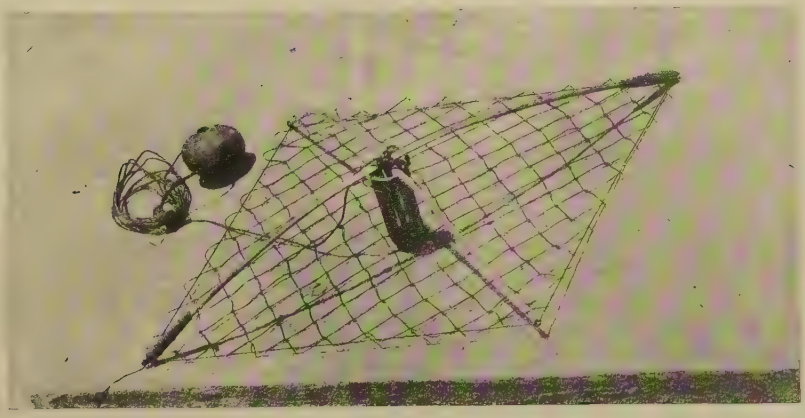

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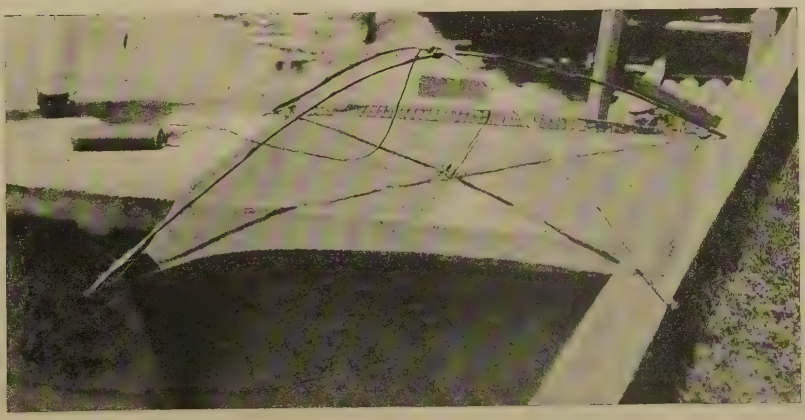

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PLATE 1.

PLATE 2. SAKAG BEING DRIED.

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PLATE 3.

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PLATE 4.

PLATE 5.